THE

ELECTRICAL REVIEW.

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THE

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REFUSE DESTRUCTORS FOR ELECTRIC LIGHTING.

AFTER some months' experience in trying the effect of ash-bin refuse, Mr. T. W. Baker makes some interesting remarks in a contemporary. From his experiments he concludes that 1 lb. of breeze sifted from the Paddington refuse will evaporate 2½ lbs. of water; the average consumption has been 6 tons of breeze and 1 ton of coal, costing 42s., which, with a steam-jet forced draught, has done the work of 3 tons of Cannock Chase coal costing 63s.

Mr. Baker places no reliance on refuse used alone, nor does he favour its use unsifted. He says coal must be burned in a supplementary furnace to secure high pressure steam for modern engines and cremate the obnoxious gases from the refuse furnace. It is just this point which presents practical difficulties that may have great weight with some people. If refuse were merely what its name implies, ash and clinker, it could be sifted and burned without any additional cremation, but it is because it contains so much wet and decaying matter that its destruction is called for at a high temperature, and any attempt to absorb heat from the burning mass during destruction requires to be carefully carried out, for the destruction of refuse is, primarily, a sanitary consideration. Furthermore, we are of opinion that with improvements in the cellular method of destruction, in brick chambers, better results may yet be obtained than have hitherto existed. The cooling effect due to air filtration through large exposed surfaces of dry brickwork may be materially reduced, and with a suitable boiler good results secured. Mr. Baker, as above stated, does not depend on the refuse, but he says the refuse will absolutely fill stand-by losses, and for this it does seem to be fairly well suited. Such losses are apt to add very materially to the expense of working an electric light station, and may well be met by utilising what would otherwise be wasted; but there is an enormous difference between the moderate claims put forward by Mr. Baker and the ridiculous figures attempted to be foisted on the public by speculative promoters. Progress must be slow and in a large degree tentative, and such progress will be none the slower because of a reasonable recognition of the extreme poverty of refuse as a whole, and the absolute necessity of sacrificing its useful effect to the sanitary conditions to be filled. A red heat temperature ought to be attained by every particle of gas from refuse combustion. It is extremely doubtful if such a temperature can always be secured in any water-cooled furnace with fuel that can only evaporate 2½ lbs. of water per pound. Mr. Baker evidently realises this difficulty, and meets it, or attempts to meet it, by introducing the additional furnace with, to quote his own words, "some high class fuel, whether

coal, gas, or oil." Of a total of 100 tons of refuse, he assumes that 70 per cent. will disappear in the furnace, leaving only 30 per cent. for final cartage or barge removal. Such being the case, we are surprised that so low an effect as only 2½ lbs. of evaporation is obtained, unless a large proportion of the 70 per cent. consists, as it probably does, of water.

The whole question of house refuse is one of education. It is only because of the very low level of intelligence and care that characterises the majority of household fuel consumers and refuse makers that there is any value whatever in ash-bin refuse, or any need to cremate it, excepting where the house fuel is gas or oil, for there is no difficulty with a coal or coke fire in the destruction in every house of all refuse as soon as formed, before it has had time to develop any harmful qualities. It is in this direction that the solution of the question should be sought rather than in that of electric lighting. The attitude of the average female to the question of fuel economy is one of unrelenting antagonism, hence the ash-bin and its contents both wet and valuable. The utilisation of refuse is but a recognition of ignorance.

The Patent Agent as Physician.

Mr. Edward P. Thompson, M.E., holds forth in *Cassier's Magazine* on the importance of "Engineering knowledge in patent practice." It appears that in the United States the inventor shows a preference for the mere lawyer without engineering knowledge, as an agent for obtaining his patent. We do not know whether this tendency prevails to any extent in this country, but we agree with Mr. Thompson that if the inventor employs as an agent, a mere lawyer unacquainted with technical terms and incapable of understanding drawings, he runs considerable risk of losing his patent. The patent agent nowadays must possess a most extensive technical knowledge, since inventions cover the whole field of applied physical and chemical science. Mr. Thompson compares the patent agent to the physician "who must be better acquainted with the disease than is the patient." This simile contains perhaps more truth than the writer intended. The mania for inventing is often a disease —witness the large percentage of worthless inventions yearly granted by the patent office, specifications of which cumber in countless heaps the shelves of our technical libraries. It is the duty of the patent attorney, if he is the physician, to abate this malady and not simply to bleed his patient. We think, however, that the patent office, not the patent agent, should perform for the inventor this duty of the physician. A judicious examination of inventions by the patent office and the rejection of those that are obviously old or worthless, would result in a great saving to the pockets of inventors, and the removal of vexatious obstructions to the progress of manufactures.

Harmonics in Alternating Currents.

It is well known that an expression for any given form of periodic current or E.M.F. can be worked out by Fourier's series in a set of simple harmonic terms of different amplitudes and phases. Mr. Kennelly and Professor Houston briefly point out some of the consequences of this in a short article in our contemporary, the *Electrical World*. One of the most interesting deductions is that even harmonics cannot exist in practical curves, as the curves are then unsymmetrical about the time axis, which is impossible. They also point out the importance of designing machines to give, as far as possible, curves devoid of harmonics, owing to the increased possibilities of resonance and impedance effects when the harmonics are present.

Electrosynthesis.

In noticing some new researches a short time ago, we had occasion to recognise the advent of a novel term in electrical technology, viz., *electrosynthesis*. The term has come to stay, and appears destined to mark a strong movement into a field of research which, hitherto, has been but slightly explored. The June issue of *Science Progress*—the new monthly review of current scientific investigation—contains an interesting paper by Dr. Jas. Walker, which should be perused by all who endeavour to keep pace with the developments which are being brought about, as chemistry and electricity go hand in hand. The writer suggests that, possibly, we owe the first example of electrosynthesis to the electrochemical theory of Berzelius, which for nearly thirty years held the field to the practical exclusion of all others. This theory served good purpose, but in these days we conceive the phenomenon of the passage of an electric current through an electrolytic solution by the aid of theoretical methods based on the researches of Faraday and Hittorf. The new views promise to give direction to research which the older theories were incapable of. Much of Dr. Walker's article presumes an acquaintance with organic chemistry on the part of his readers, which in view of the stated objects of *Science Progress* cannot be complained of. We could have wished, however, for the sake of many who might be deterred from a study of the article, that it had been possible to give other examples of the formation, by means of the electric current, of complex compounds from simpler ones—examples which might be more suggestive of practical and commercial applications. These will doubtless come in course of time. At present, electrosynthesis as a branch of the science of electricity, is in its infancy.

Is an Electrolyte Essential to Chemical Change?

It is well known that Dr. Armstrong, the distinguished president of the Chemical Society, holds the view that the presence of an electrolyte is essential to every chemical change and that water is of service because it gives rise to an electrolyte. The question has recently arisen in chemico-physical circles whether other substances besides water can condition the formation of electrolytes, and thus co-operate in producing change. An outcome of this question is provided by Mr. H. Brereton Baker's recent paper on chemical action. The results stated support Mr. Shenstone's conclusion that possibly some substance other than water is essential to chemical change. Mr. Baker believes that an electro-chemical hypothesis is applicable. When dried ammonia and hydrogen chloride gases are mixed, and plates bearing opposite electric charges are introduced, separation takes place, though the action cannot be electrolytic since discharge is, under the circumstances, impossible. Similar separation has been noticed with air and with a mixture of dried hydrogen and oxygen. Electric discharges, when not of high tension, will not pass in dried gases; but the high tension discharge does pass and renders it possible for the low tension discharge to pass afterwards; and with regard to the influence of moisture, it appears that what holds for chemical combination holds also for electrical discharge. There is great significance in the apparent similarity in the two cases.

THE BOLOMETER.

A DESCRIPTION of this exceedingly sensitive and simple instrument for measuring heat has been recently given by Dr. M. Th. Edelmann, of Munich, one of the original inventors of the instrument. In 1873 the late Dr. C. Lang and Edelmann, while engaged in the investigation of the dark lines in the heat spectrum, hit upon the idea of allowing the radiation to fall upon thin stretched iron wires, and then measuring the change of resistance produced by the heating, by means of a Wheatstone bridge. They used the apparatus about to be described, and could, even at that time, using a

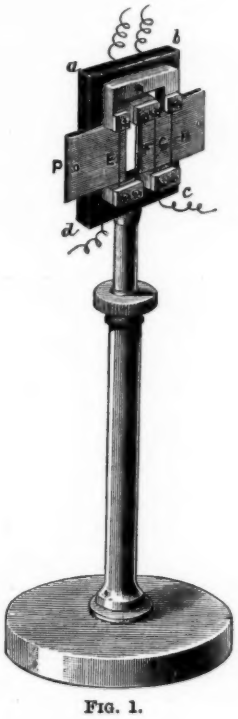


FIG. 1.

Wiedemann's galvanometer, detect the D line on the bridge wire. They refrained, however, from publication because they discovered nothing new, and because this method of measurement appeared to have no essential advantage over a linear thermopile. By chance, a similar method of measurement was tried by others, and later the name of bolometer was given to the instrument. In the course of last year, by means of the exceedingly sensitive Rosenthal microgalvanometer, they were able to give to the bolometer an extraordinary degree of sensitiveness.

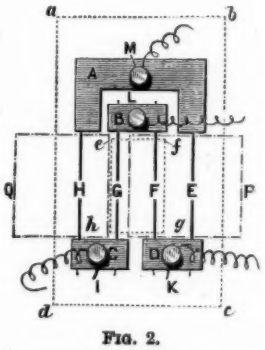


FIG. 2.

Upon a rectangular vulcanite board, *a*, *b*, *c*, *d* (in the middle of which a rectangular opening, E, F, G, H, is cut), the brass blocks, A, B, C, D (fig. 2.), are screwed. Between these four thin blackened iron wires are stretched. These four wires form the four branches of a Wheatstone bridge, the terminal screws, I and K, serve to connect up the battery to the bridge, and the screws, L, M, for the introduction of the Rosenthal microgalvanometer, or any other highly sensitive galvanoscope. The wire, E, is of somewhat higher resistance than the other three, and a rheostat is inserted between the screws, K and M, as a shunt to E, to enable the balance to be adjusted to bring the needle of the galvanometer to zero.

The side of the instrument, shown in fig. 1, is fitted with a wooden cover, having ventilation holes above and below. It is fixed to the vulcanite board, *a*, *b*, *c*, *d*, by a hinge, so that it can be easily opened. The two slides, P, Q, serve to reduce the opening, E, F, G, H, to a small slit in front of one of the wires, F, G. All four wires are coated with thin black pigment, and have each a resistance of 0·1 ohm, as also the microgalvanometer. With this arrangement, a temperature difference of one ten-thousandth of a degree Centigrade, between the wires F and G, will give a deflection of 20 mm. at a metre distance, with a current of 0·25 ampères in the main circuit. The rheostat is used to bring the galvanometer to zero before the experiment.

ESTIMATE OF THE DISTANCE TO WHICH NIAGARA WATER POWER CAN BE ECONOMICALLY TRANSMITTED BY ELECTRICITY.*

BY CHAS. E. EMERY.

THE writer is very grateful to the distinguished electrical engineers, Messrs. Houston and Kennelly, for their very elaborate and interesting paper on this important subject, and appreciates the compliment implied by the comparison of the results of their work with those stated in his paper on the "Cost of Steam Power."† The results shown are gratifying and surprising, and as a full discussion only serves to emphasise the truth as it appears from various points of view under various conditions, it is proposed to suggest some changes in the data assumed, which it is hoped will be accepted and finally assume a difference in prices which it is thought must be provided for in practice. The result is apparently to reduce materially the radius of economical transmission of water power electrically, compared with steam generated and utilised on the spot.

In the first place it should be noted that, in very large plants, steam engines can be operated somewhat more economically than the 500 H.P. units of the writer's paper, as was indeed suggested by Prof. Forbes in discussing the paper. Again, Messrs. Houston and Kennelly have charged only 10 per cent. for annual cost of interest, depreciation, and repairs, whereas in our paper 5 per cent. is allowed for insurance, taxes, and depreciation, 10 per cent. for interest or dividends, so that according to the practice of promoters 5 per cent. interest may be paid on bonds equal in amount to the original cost and 5 per cent. dividends on an equal amount of stock. In addition to this, 2½ per cent. is provided for inspection and 6 per cent. for loss of interest during construction; making in all, if inspection be omitted (as the authors have an item for superintendence), 21 per cent. added to the cost, in our paper, for items which the authors of the paper under discussion have only added 10 per cent. For an entirely new work like that in connection with Niagara, the loss of interest during construction will necessarily be very great; but not to take too extreme views, in the modified estimates herewith submitted, only 15 per cent. has been added for interest and the various other charges proportioned to the original cost, instead of the 21 per cent. used by us, or the 10 per cent. used by the authors of the paper.

Again, it is considered that the efficiency of the generators assumed in the paper, viz., 0·94 according to the calculations (though the types state 0·96), is too high. The simple electrical efficiency of an alternator, considering the copper losses only, can readily be made as high, or higher, than that of a direct current dynamo, but it does not seem possible to make the iron losses as low on account of the comparatively

* N.Y. *Electrical Engineer.*

†Read before the American Institute of Electrical Engineers, March, 1893. Also N.Y. *Electrical Engineer*, March 29th, 1892.

high frequency. We have therefore based our amended calculations on an efficiency of 0·90, which is higher than can probably be realised when the load averages less than full, and the copper, iron, and strictly mechanical losses are all considered. We have also thought it safer to use 0·96 as the efficiency of the transformers during average work, instead of 0·98 used by the authors of the paper. Our recollection is that comparatively recently the iron losses alone were considered by Mr. Stillwell to be 5 per cent. The combined efficiency of the generator and transformer will then be $0·90 \times 0·96 = 0·864$, and on the basis that the same joint efficiency will be obtained with the transformers and motors at the end of the line, the combined efficiency of the generator, the motor, and the step-up and the step-down transformers will be $(0·864)^2 = 0·7465$, or, say, 75 per cent.

The very low price of large generators and motors stated will be a gratifying surprise to many, and a careful perusal of the paper shows that this low price is one of the principal elements which makes the transmission through the long distance referred to appear practicable. There is, however, an enormous difference in prices stated in the paper for motors of different sizes, viz., $100 per kw. for very small motors, $45 per kw. for 50 kw., and only $8.516 per kw. for 1,000 kw. Accepting, however, without question, the authority of the paper in relation to the cost of the very large generators which can be employed at Niagara, and also the fact that corresponding transformers will be furnished for $4.72 per kw., the cost of the two will be $13.236 per kw., as in the paper; but on account of the change of assumed efficiencies, the cost, referred to the energy actually delivered by the generators, will be $13.236 ÷ 0.864 = $15.32 per kw. It is suggested that this price is altogether too low for the conditions which, on the average, will obtain for the motors where the power is delivered. It will probably not be thought proper to bring the very high voltage used in transmission into a city, and it will not in general be practicable to operate outside the city limits with a few large motors the local machinery in the city without a second transmission and its attendant losses. It is, moreover, a question whether the frequency adopted for the long distance transmission will be suitable for lighting, and extremely doubtful if direct transformation from the long distance circuits should be risked for local lighting circuits. It is probable, therefore, that special motors will be located in each of the several manufacturing establishments in the city, including those for electric lighting and power purposes, and that such special motors will be operated by current from the step down transformers outside the city limits. On this plan the very small motors would be operated from the local circuits as at present. The special motors, operated as part of the transmission system, would, on the average, be small compared to the size of the generators available at Niagara, and therefore the average price be higher. It is therefore submitted that it will be fair to consider the cost of motors raised from $9.581 per kw. assumed in the paper to at least $15.28 per kw., to which, adding transformers at $4.72 per kw., gives as the joint cost of both $20 per kw. Adding to this only 50 per cent. for spare machinery, a high tension line terminal in the suburbs, and sundry details which do not appear to have been considered in the table, we obtain $30 per kw. as the more probable cost of the motors, transformers, &c., in the vicinity of the city to which the power is to be transmitted, or for the power actually delivered by the motors 30 ÷ 0.864 = $34.72 per kw. The accuracy of this assumption can only be proved by carefully considering the details of an actual application; but if the figures given be considered simply an assumption, they will show the influence that the slightly lower efficiencies and somewhat greater increased costs assumed have on the final result. Amended calculations of the results given in the paper under discussion for Buffalo and Syracuse are herewith presented. The description of the several lines is substantially the same as in the paper, and it will be found very convenient for those perusing this discussion to number the lines in the original paper to correspond with the numbers herein.

It thus appears that, on the basis assumed, Buffalo is within and Syracuse outside the circle of economical transmission for a 10-hour day, and that for a 20-hour day both cities are included in such circle. Most of the demand will probably be on a 10-hour basis, the power and lighting periods occurring at different times and overlapping each other. Mills, paper manufactories, &c., requiring power for 24 hours can best be located directly at Niagara Falls and secure the undoubted low rates that will obtain there. It is thought that the first transmission installation which will naturally be for Buffalo will cost even more than estimated above, as time and some tentative work will be required before the application becomes general. The estimate makes no provision for subways, which must be constructed to all points reached. The costs may rise so high that even the transmission to Buffalo will pay only a small percentage on the cost, and conditions better than assumed must be found before there will be much of a market elsewhere.

Table showing the cost of transmitting the water power of Niagara electrically to Buffalo and Syracuse, on the basis partly of the quantities given in the original paper of Messrs. Houston and Kennelly and partly of the modified quantities referred to above:

No. of line.		Buffalo.	Syracuse.
0	Distance	15 miles.	164 miles.
1	Maximum delivery ...	22,500 kw.	7,500 kw.
2	For a delivery for a full load motor shaft of ...	1.000 kw.	1.000 kw.
3*	The delivery at line terminals will be $\frac{1}{0·864}$ ...	1.157 kw.	1.157 kw.
6	Total copper in the line per kw. delivered ...	17.82 lbs.	194.8 lbs.
7	Approximate loss of energy in line	0.0392 kw.	0.4286 kw.
8*	Approximate energy delivered at Niagara line terminals = line 3 + line 7	1.196 kw.	1.586 kw.
9*	Approximate energy delivered at turbine shafts = line 8 ÷ ·864 ...	1.384 kw.	1.835 kw.
9a*	Efficiency of the transmission for full load ...	0.7225	0.5450
9b*	Ditto for 60 per cent. of full load, about... ...	0.4335	0.3270
10*	Cost at Niagara of 1.190 kw. for Buffalo, and 1.586 kw. for Syracuse, at $15.32 per kw.	$18.322 per kw.	$24 298 per kw.
11	Cost of copper in line at $0.125 (see lbs. line 6)...	2.228 „	24.350 „
12*	Cost of 1 kw. at Buffalo and Syracuse respectively, at $34.72 per kw. as explained in text ...	34 720 „	34.720 „
13*		$55 270 „	$83.368 „
14	Cost of line at $1,000 per mile (see line 0) ...	0.67 „	21.87 „
15*	Total investment... ...	$55 94 „	$105.24 „
16*	Annual cost of investment at 15 per cent.	$8.39 per kw.	$15.79 per kw.
17*	Cost per kw. at turbine shaft at $4 (see line 9)...	5.54 „	7.34 „
18		$13.93 „	$23.13 „
19	Labour, superintendence and general expenses ...	2.68 „	2 68 „
20*	Annual cost at sustained full load...	$16.61 „	$25.81 „
21*	Annual cost at 60 per cent. full load...	$27.68 „	$43.02 „
22*	Annual cost at 60 per cent. full load...	$20.65 per H.P.	$32.09 per H.P.
23	By Emery's tables† the cost of generating steam power with coal at $3 per ton for a year of 308 days of 10 hours ...	$25.27 „	$25.27 „
24	By Emery's tables† the cost of generating steam power with coal at $3 per ton for a year of 365 days of 20 hours ...	$44.43 „	$44.43 „

* This mark designates the lines which are modified by the considerations stated in the text.

† This is with large triple expansion compound engines, as per lines J and K of table in *Transactions* American Institute Electrical Engineers, March, 1893.

The estimates show plainly that the allowable first cost of developing a water-power in competition with steam, stated in our paper as $140 per H.P. on a 10-hour basis, is in connection with a transmission plant, greatly modified by the efficiency of the transmission stated in lines 9*a* and 9*b*.

EXPERIMENTS ON BROWN'S ALTERNATING CURRENT MOTOR.*

By RICCARDO ARNO.

Dr. Banti published, a few months ago, the results of a series of experiments executed upon some Brown asynchronous motors, respectively of $\frac{3}{4}$, $1\frac{1}{2}$, and 3 horse-power.

Having been induced in the past month by the courteous instructions of Signor Carlo Sutermeister to conduct some experiments in concert with the engineer Nizzola, of the firm of Brown, Boveri & Co., on such motors of a power greater than those experimented on by Banti, I think it well, as a new contribution to a knowledge of the properties of the motors in question, to explain the results of the measurements undertaken.

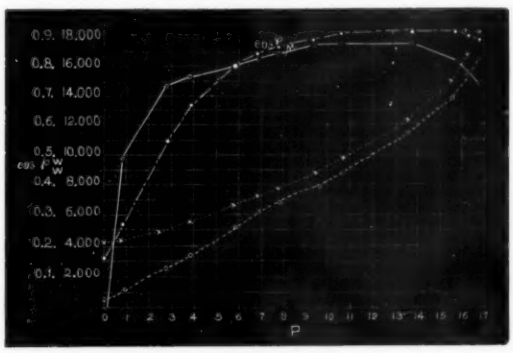
The motor experimented with has been introduced for about two months in the circuit of the great transmission of electrical energy by means of alternating currents on the property of Signor Carlo Sutermeister, at Intra (Lake Maggiore). Like all the motors of this type, it is without any sliding contact, and is of an extremely simple construction, and worked, whilst running, as a motor with a revolving magnetic field, and in the period of normal working as a motor with a synchronous monophase alternating current. The length is 480 mm., its breadth 600 mm., and its height 615 mm. The total weight, including the pulley keyed on the shaft, is 545 kilos. It has been constructed by Brown, Boveri & Co., of Baden, as a 15 H.P. machine, a frequency of alternating current = 40, a difference of effective potential of 150 volts, and a velocity of about 800 revolutions per minute. In its normal work there was no excessive heating, and it acted without noise.

Having applied the brake to the motor, there were measured simultaneously: the force applied to the arm of the lever (1·27 metre in length) by means of a counterpoised balance and a quadrant previously tared; the electric energy by means of a Ganz wattmeter; the effective intensity of the current and the difference of effective potential respectively with two Siemens electro-dynamometers in parallel, and with two voltmeters, one of Cardew, and the other of Hartmann and Braun, in series, and the velocity by means of a contact wheel.

The results of the experiments are summarised in the subjoined table. Of these experiments, 14 in number, the first and second correspond respectively to the first moments of the period of action, and to the wheel-work of the motor; the 3rd, 4th . . . 11th refer to the ordinary work which ought to proceed from smaller to heavier loads, and the three last refer to the action of the motor above mentioned.

The table comprises 14 columns, in which are respectively registered the successive number of the experiments; the velocity, n, of the motor expressed in turns per minute; the electric energy, W, consumed, expressed in watts; the difference of alternating effective potential, V, in volts: the effective intensity, I, of the alternating current in ampères; the force, F, in kilos. applied to the arm of the brake; the mechanical energy recovered expressed in horse-powers (P) and in watts (736 P); the industrial field $\mu = \frac{736\ P}{W}$; the apparent electric energy expressed in watts, $w = V\ I$; the cosine of the difference of phase, ϕ, from the difference of effective potential and the effective intensity of the current (power factor) given by the ratio $\frac{W}{w}$; the angular value of such difference of phase; the difference, $w - W$, between the apparent electric energy and the effective energy; the value, $1{,}000\ \frac{w - W}{W}$ of such difference referred to the kilowatt.

If on two orthogonal co-ordinate axes there are plotted out as abscissæ the values of P, and as ordinates respectively



the values of W, w, μ, cos. ϕ, there are found points, disposed as indicated in the figure, indicating clearly the manner of behaviour of the motor experimented with according to the various loads imposed.

No.	n	W	V	I	F	P	736 P	$\mu = \frac{736\ P}{W}$	$w = V\ I$	$\cos\phi = \frac{W}{w}$	$\phi°$	$w - W$	$1{,}000\ \frac{w - W}{W}$
1	0	17,595·0	132·0	150·0	1·50	0·	0	0	19,800·0	0·889	27° 20′	2,205·0	125·3
2	876	688·5	157·5	27·0	0·	0·	0	0	4,252·5	0 162	80° 40′	3,564·0	5,176·5
3	862	1,173·0	156 5	27 5	0·50	0·78	574·1	0·49	4,303·7	0 273	74° 10′	3,130·7	2,669·0
4	863	2,652·0	155·0	30·8	1·70	2·64	1,943·0	0 73	4,774·0	0·556	56° 10′	2,122·0	800·2
5	866	3,774·0	157·5	35·7	2·50	3·90	2,870·4	0·76	5,630·6	0·670	48° 00′	1,856·6	491·9
6	868	5,176·5	156·0	41·8	3·60	5·62	4,136·3	0·80	6,520·8	0·794	37° 30′	1,344·3	259·7
7	863	6,171·0	154·5	47·3	4·45	6·91	5,085·8	0·82	7,307·8	0·844	32° 30′	1,136·8	184·2
8	862	6,732·0	154 0	50·6	4 95	7·68	5,652·5	0·84	7,792·4	0·864	30° 10′	1,060·4	157·5
9	859	7,854·0	152·0	57·2	6·10	9·43	6,940·5	0·88	8,694·4	0·903	35° 30′	840·4	107·0
10	858	8,823·0	151·0	63 8	6·80	10·50	7,728·0	0·88	9,633·8	0·916	23° 40′	810·8	91·9
11	856	11,398·5	149·0	82 0	8·80	13·56	9,980·2	0·88	12,218·0	0·933	21° 10′	819·5	71·9
12	851	13,923·0	146·5	102·0	10·10	15·47	11,385·9	0·82	14,943·0	0·932	21° 20′	1,020·0	73·3
13	812	15,478·5	143·0	118·2	11·05	16·15	11,886·4	0·77	16,902·6	0·916	23° 40′	1,424·1	92·0
14	816	16,626·0	144·0	128·0	11·40	16·74	12,320·6	0·74	18,432·0	0·902	25° 30′	1,806·0	108·9

* Extracted from the *Electtricista*, Vol. iii., No. 7. Rome: Widow Pateras.

THE TELEPHOTOS.

The cuts shown on the next page outline a novel invention of Mr. Claudius Victor Boughton, of Buffalo, U.S.A., which we have critically examined, and which for its simplicity of construction, its entire freedom from complicated mechanism, the accuracy with which it responds to calls made upon it, and the literally A B C knowledge only needed to operate it, is a method of signalling by light which it would be difficult to improve upon.

The invention is named "Telephotos," and is a signal telegraph, consisting essentially of a receiving apparatus formed of a number of electric lamps arranged in a continuous line, and of a transmitting keyboard consisting of a bedplate of non-conducting material, a series of metal strips insulated from each other in the bedplate, each strip being electrically connected with a separate lamp, and contact plates each operated by a separate key to complete the cir-

cuits, through different groups of the metal strips, to light the lamps necessary to produce the character desired.

The lamp shaft, a portion of which is shown in fig. 1, is lamped for the International Morse Code, and consists of five red 75 C.P. lamps for dashes, and six white 50 C.P. lamps for dots, the red and white lamps being arranged alternately. The shaft is 9 feet long and has

Fig. 1.

a diameter of 6 inches, but obviously its length is not a fixed factor, and probably lies between 6 and 18 feet; it is round, and consequently symbols exhibited on it can be read from every point of the compass. The non-conducting bed-plate, the insulated metal strips and contacting plates, with the keys operating them (fig. 2), are contained in a weather-proof metal case 15 inches × 8 inches × 3 inches, on the outside upper surface of which, and over the keys, are button-headed pins marked with a letter of the alphabet—a numeral or special sign—and with these the circuit is opened and closed.

A simple arrangement of bicycle balls in a grooved slot beneath the keys, having amongst them $\frac{1}{16}$th of an inch lost motion, effectually prevents the contact of more than one key at a time, and this part of the invention has many uses besides the one to which the inventor has put it in the telephotos.

A recording instrument, consisting of the arms of the ordinary type-writing machine worked by magnets, lettered and numbered, reproduces in Roman characters, &c., upon a paper tape the letter or numeral on the button of the key depressed to show its symbol on the light frame, but it need not necessarily be attached to every key-board.

The signals are made up, it will be understood, of a series of red and white lamps; thus, on depressing key "A," a white, and, below it, a red lamp, are illuminated, corresponding to · — of the Morse code. If "B" is depressed, then a red lamp, and below it, three white lamps, are lit up, corresponding to — · · ·

ELECTROSTATIC ROTATIONS IN RAREFIED GASES.

This subject has recently been examined by Prof. Riccardo Arnò, who has courteously forwarded us a copy of his memoir as inserted in the *Atti della Reale Accademia delle Scienza di Torina.*

The author after referring to the radiometer of Crookes, takes for his subject the explanation of some experiments which show clearly how a phenomenon of the same nature may be obtained by submitting the rarefied gas in which the mill is immersed to the action of a rotating electrical field.

The same method which he has formerly used has enabled him to produce the rotating field necessary for his experiments by recurring to a simple difference of potential alternating between two fixed points represented by the extremities of the secondary spiral of a large Ruhmkorff's bobbin deprived of its commutator, and acting therefore like an ordinary transformer for alternating currents. He writes:

"To demonstrate the novel phenomenon of which I have been speaking, not being able to utilise the ordinary radiometers with vanes of mica, since when they are contained within gas at the ordinary pressure forces are exerted due to the action of the rotating electric field on the mica, I have had recourse in my experiments to a special apparatus suitably constructed, formed of a mill, *m*, with four very slender vanes of brass, movable in a glass globe, v, containing air brought to the utmost state of rarefaction. It is only, indeed, when experimenting on a completely metallic mill that I have been able to be certain of having absolutely eliminated every direct action of the rotating field on the vanes of the mill that I could verify with certainty the novel effects due to the presence of rarefied gas.

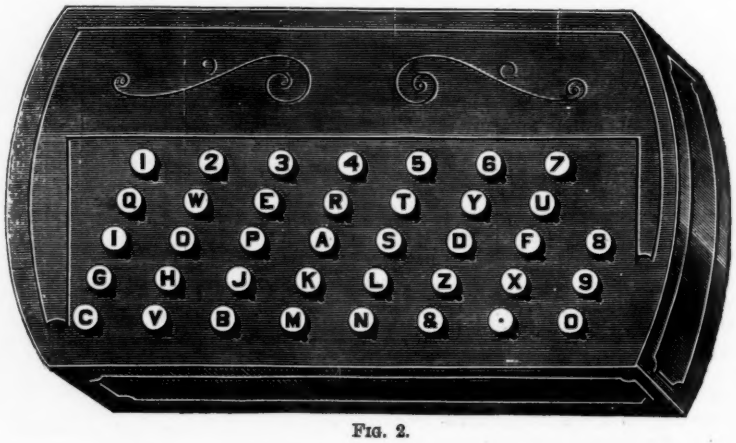


Fig. 2.

"If the apparatus is placed in the space enclosed between two couples of sheet copper, A B and A′ B′, it is observed when the intensity of the field is sufficiently great, and the glass case of the apparatus is properly dried, that the brass vanes begin to rotate according to the rotation of the field. And if, whilst it is revolving in one direction the rotation of the field is inverted, the metallic mill also begins to revolve in the opposite direction.

"In my experiments, executed with an alternating current of a frequency equal to 40, and with a distance of 15 centi-

metres between the plates, the difference of effective alternating potential between the extremities of the secondary spiral of the bobbin will be equal to about 7,500 volts. Under these conditions to which there corresponds an electric field revolving at the rate of 40 turns to the inch, and of an intensity equal to 1·67 C.G.S. electro-static units, the metallic mill may acquire a velocity of about 50 turns per foot.

"I have said that to place in clearness the new phenomenon in question I happened to experiment on mills with conductive wheels. I must add a condition necessary to avoid the direct action of the revolving electric field on the mill. Suitable experiments which I have instituted demonstrate, in fact, that whilst in air at the ordinary pressure four leaflets of mica laid across rotate, like any dielectric substance, with the electric field in which they are placed, the couple, although minute, acts upon a mill which is entirely of metal and which, though suspended in a rotating field of great intensity by means of a thread of silk of the smallest diameter and very long, remains fixed in the same field.

"I will say finally that in the conditions in which I have experimented the action of the rotating electric field on the rarefied gas were such as to illuminate uniformly the interior of the glass globe, so that even when experimenting in complete darkness it was possible to distinguish the mill in rotation so clearly as to count the number of turns."

RESUSCITATION AFTER ELECTRIC SHOCKS.

By Dr. A. D'ARSONVAL.

In my paper of April 4th, 1887, I showed that electricity occasions death in two very different manners:—

1. By lesion or destruction of the tissues (disruptive and electrolytic effects of the discharge).

2. By excitement of the nerve centres, producing the arrest of respiration and syncope, but without material injuries.

In the former case the death is final; in the latter it is merely apparent. I have proved that it is then possible to resuscitate the victim by means of artificial respiration. I have been able to sum up my numerous experiments in the following practical formula: *A man struck by lightning should be treated like one drowned.*

Taking my stand on these facts, I have protested against the penalty of death inflicted in America under the (barbarous) name of *electrocution*, the industrial alternating current employed in this case producing nearly always the second kind of death.

An accident which happened in the last few days—the conditions of which could be ascertained with all the precision of a laboratory experiment—has just confirmed in man what I have seen in the lower animals.

This is an account of the case as communicated to me by MM. Picou and Maurice Leblanc, two well known electricians, eye-witnesses of the accident, and restorers of the person "electrocuted."

When the accident occurred at Saint Denis, the electrometer of Epinay, fixed between two of our three wires, marked 4,500 volts, and the ammeter, inserted in one of them, showed 750 milliampères.

At the place where the disaster occurred the three wires are supported by a small post fixed to a wall at about 6 metres above the ground. The man who was struck was astride on the lower connecting bar holding in one hand one of the conductors. He had carried with him a telephone wire which he was about to fix. This wire rested on the connecting bar and touched another of the three conductors.

The current was closed through the man, entering by one hand and escaping in short circuit by one buttock.

He had, therefore, undergone directly the whole tension (4,500 volts, frequency about 55). It is difficult to say exactly how long, but certainly for some minutes. The short circuit which he occasioned led to the production of sparks at the collector of the Epinay apparatus. The agent superintending suspected an accident and telephoned to La Chapelle to stop. All this represents a rather long time.

At this instant we were setting out from Epinay, and were already in the train, when we were informed that an accident had just happened.

About a quarter of an hour after we arrived at St. Denis; this man was still astride on the connecting bar, and no longer showed any sign of life. It was very difficult to take him down, and this operation took at least half an hour.

Following your advice we practised artificial respiration (working the arms), but at first without result. I then forced open his mouth and loosened the tongue, when his lungs began to act almost immediately. In two hours he was able to speak. He was burnt at the right hand and on the buttock. To-day he is doing well.

Some days ago they informed me again: "The injured man is doing well. It must be noted that no particular trouble, due to the passage of the current through the body, has been manifested. It is merely needful to attend to the burns."

All comment seems to me superfluous, and I merely repeat in conclusion: A man struck by electricity should be treated as if drowned.

* *Comptes Rendus*, Vol. cxviii.

HAMBURG ELECTRIC TRAMWAY.

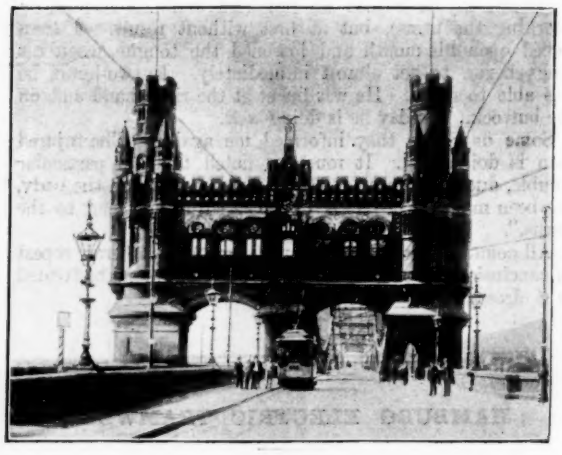
Some few months have now elapsed since the opening of the electric tram lines in Hamburg, equipped on the Thomson-Houston system by the Union Elektricitaets-Gesellschaft, of Berlin. The Ringbahn section was started in February, and soon afterwards the lines Veddel-Schlump and Eimsbütteler Kirche-Pferdemarkt were inaugurated. There is now regular traffic with 36 motor cars, most of them taking tow cars with them.

When the question of electric traction came up in Hamburg, it was at once generally recognised that its solution lay in the direction of the overhead trolley system. The conduit system, for instance, was seen to be impracticable owing to the comparatively rigorous climate and to the fact that the boggy nature of the ground rendered the maintenance of canalisation, pavement, and other street works, like building foundations, specially troublesome and liable to frequent change, and consequently expensive; while it was considered that the storage battery system could not be regarded as on a sufficiently sound basis to warrant its application on such an extensive scale as was required in Hamburg. After very thorough consideration, then, of all the factors of the case, on the part of the city engineers, permission for the installation of the overhead system was finally granted by the Senate of the State of Hamburg, the members of which were at the same time, in this instance, the municipal authorities.

The current for the operation of the line is taken from the municipal central station, situated in the Poststrasse, where special generators for the tramway service have been installed. The working pressure fluctuates between 500 and and 550 volts, according to the load. The feeders connecting the power station with the overhead line consist of the well known Felten & Guilleaume cables, laid underground. They join the overhead line at the following three points, which have been chosen with special regard to the heaviest gradients:—1. Corner of Lager and Karolinen-Strasse; 2. Landing stages at St. Pauli; 3. Berlin Railway Station; the current first passing through electric meters installed in the waiting rooms of the tramway at these locations. The rails, which are bonded together by bare copper wire, form the return circuit, being directly connected to the generators by underground insulated cables. Earth plates are not used.

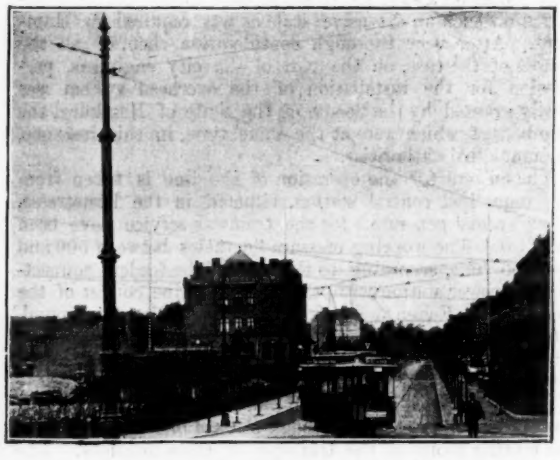
The overhead line, which is of hard-drawn copper wire of 53 square mm. cross section, does not form an uninterrupted circuit; it consists, rather, of a number of distinct sections, each of about 500 metres in length, separated from each other by "section insulators," as they are called. At the end of every such section a switch is installed, which in its normal position is closed, so that there is a continuous path for the current from the generating station to the cars on

the line; while, by opening these switches, any particular section may be cut out of the circuit. The switches are contained in locked boxes conveniently fixed to the poles carrying the trolley wire, or to the houses along the road. The keys to these boxes are at the disposal of the police and the fire brigade. In case, for instance, a fire should occur anywhere along the line, which would necessitate, for the proper and unhampered manipulation of the firemen's apparatus, the removal of the trolley wire at that point, the switches at either end of the particular section would be opened, and the portion of the line so switched out might then be taken down without interfering with the traffic on the rest of the line.



Elb. Bruche.

In order to protect the trolley wire from contact with telephone wires, in case of the latter falling by any means, neat wooden moulding is run along the top of the trolley wire, replacing very advantageously the complication of guard wires usual in other installations of the kind.

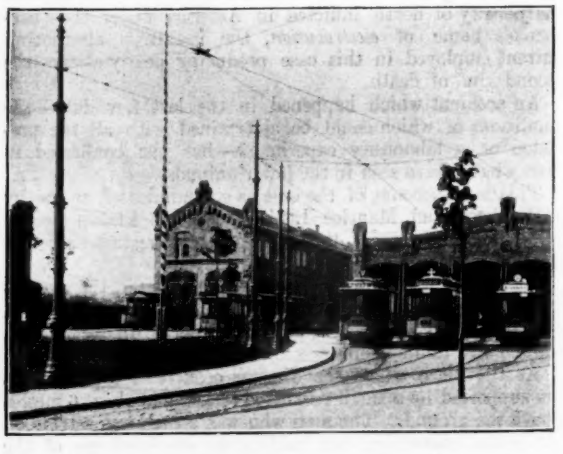


Veddul Schlump Line.

The tramway exhibits all the varieties of overhead construction. There are streets with houses on the one side and the open harbour on the other; there are narrow streets enclosed on either side by houses, and there are pleasant, shady, suburban roads and parks to be traversed. All these different conditions have naturally called for different methods of overhead construction. So much taste has been exercised in this respect, that in many places the supports of the trolley wire are hardly noticeable. The trolley wire is mostly suspended from steel span wires hung between rosettes fixed on the houses, or between ornamental steel poles. In some parts, as, for instance, on the Esplanade, the trolley wire is suspended from ornamental side brackets, which in summer are lost to view in the foliage of the trees alongside the tramway, and, in winter, rather embellish than disfigure the street. A particularly pleasing arrangement is that applied on a double-track section of the Ringbahn along the docks, where the trolley wire is carried by symmetrical double brackets on poles erected between the two lines of rails. One of the most notable features of the line is a trolley wire span of 104 metres over the Lombardsbrücke, specially supported by poles at either end of the bridge; this arrangement was adopted in order not to disturb the architectural *toute ensemble* of the structure by the erection of any poles on it. A further interesting piece of installation is on the Schlump-Veddel line, where the tramway crosses the Oberhafen Canal by a swing bridge. The trolley wire is so arranged here that the bridge can be opened at any time without hindrance to the operation of the cars which may happen to be on it.

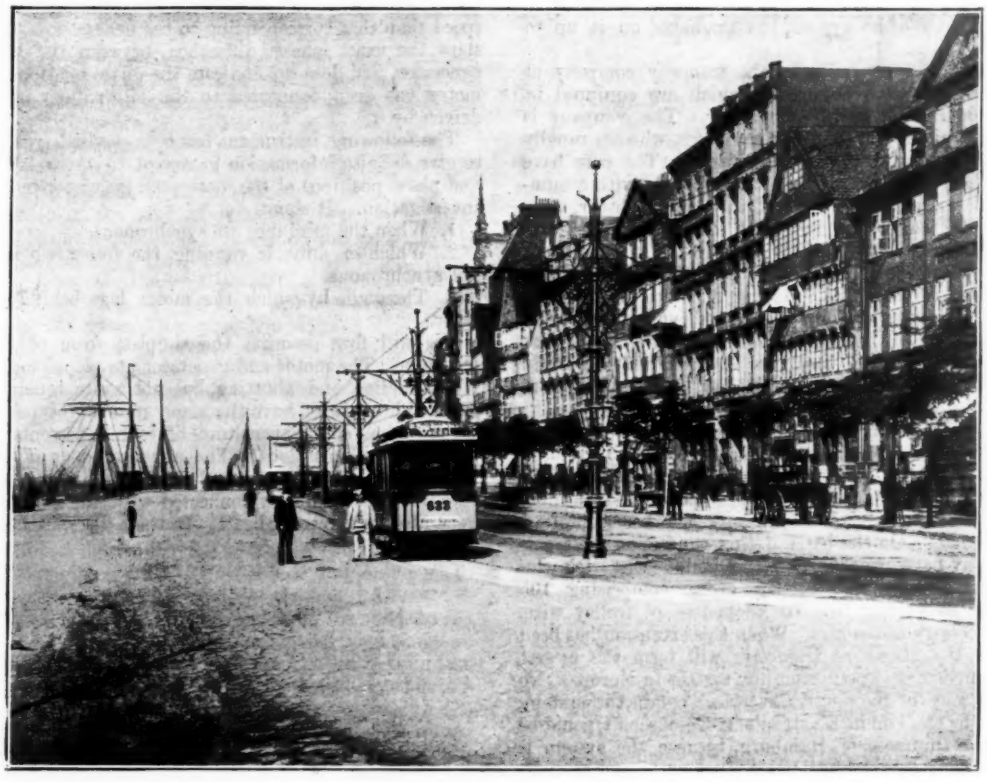
Lombardes Bruche.

More money has probably been spent in Hamburg on the pole and bracket details than on similar work in any other Continental city.



Car Sheds.

The poles employed are of steel tubing from the Rhineland, for the preparation of which some of the most important German firms have made special arrangements in their works. Of course, the object was to get a pole that would stand very severe strains without bending enough to cause a lack of symmetry in the construction as a whole.



Line along Docks.

Esplanade.

There is a gradient of 5 per cent. on the Ringbahn, which is run over with the greatest ease—a matter for no surprise, however, when it is remembered that the electric tramway in Remscheid, on the same system, has gradients on it up to 10·5 per cent.

The car bodies were built by the tramway company at their own workshops at Falkenried, which are equipped in the most modern and approved manner. The company is possessed, moreover, of a corps of engineers, who are rapidly adjusting themselves to the new conditions. The cars have turret tops, are light and airy, and are provided with a number of little conveniences in one way and another, suggested by the company's long and extensive experience. The cars are lighted by electricity, five 16-C.P. incandescent lamps being installed in each car. They are furnished with the latest type of controller, enabling them to be operated with ease and safety; they can be stopped when running at full speed much more suddenly than a horse car. The trucks, or under-frames of the cars, are of modified American pattern, and are each equipped with one 15-H.P. Thomson-Houston railway motor.

The Hamburg public are so pleased with the electric service, and the tramway company are so thoroughly convinced of its great value for them, that it has been decided to equip the whole of the system with electric traction, and the final concession for the execution of the work has been obtained from the Senate. On the basis of this concession the tramway company have placed with the Union Elektricitaets-Gesellschaft, of Berlin, a further order, comprising 105 motors, and something like 70 kilometres of trolley wire, with the necessary accessories. When this extension has been carried out, the Hamburg tramways will form the largest and most important electric tramway system in Europe. No better argument for the electric overhead conductor system, as installed by the Union Elektricitaets-Gesellschaft, could be afforded than this case of Hamburg, because the system is being applied on a scale which admits of nothing like half and-half work or experimenting.

Since the opening of the electric lines the traffic on some of the other lines has fallen off somewhat, but the total traffic receipts show an increase of nearly 15 per cent. over the receipts for the same period last year.

AN OPTICAL PHASE INDICATOR AND SYNCHRONISER.*

By GEORGE S. MOLER and FREDERICK BEDELL.

In starting a synchronous alternating current motor it is usual to bring the motor up to speed by some external means and to switch it into connection with the generator when the motor and generator are running synchronously, but are in opposite phase. Various devices have been employed to indicate synchronism, and to show when the motor is in opposite phase to the generator, one of the simplest of these devices consisting of an incandescent lamp used as a pilot lamp. The lamp is connected directly in the circuit supplying the motor, so that all the current through the motor armature passes through it. Before the motor is started the lamp glows steadily. As the motor attains considerable speed, the lamp suddenly flashes up and dies out alternately, according to whether the electromotive force generated by the motor and the electromotive force from the alternator are in the same or in opposite phases. Beats are thus produced which occur at longer intervals as the motor approaches synchronism with the alternator. When the intervals are long enough to be quite marked, the motor is connected directly to the generator circuit by cutting the lamp out at a moment when it is dark, indicating that the machines are in opposite phase. At the same time the external power, which has driven the motor to synchronism, is removed. Instead of one lamp, several lamps or a lamp together with dead resistance, may be used where required.

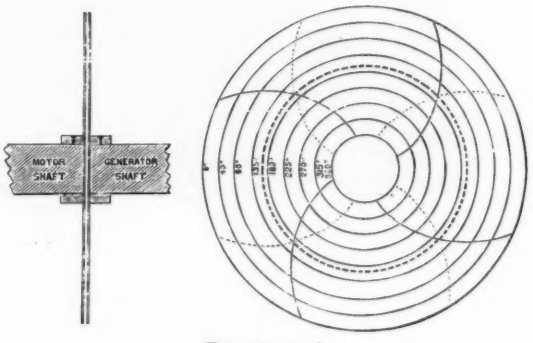
* Presented at the Philadelphia meeting of the American Institute of Electrical Engineers, May 17th, 1894.

This device is simple and efficient. It does not, however, indicate the moment when exact synchronism is reached, nor does it show whether the motor is running at a greater or less speed than that corresponding to the generator. It does not show the exact phase difference between the motor and generator, and does not indicate the phase relations after the motor has been connected to the alternator and is being driven by it.

The following instrument has been devised by the writers to give definite information in regard to the relative speeds and phase positions of the motor and generator in laboratory investigation. It shows

1. When the machines are synchronous.
2. Which machine is running the faster when they are not synchronous.
3. The angle by which the motor lags behind the generator.

We will first describe the simplest form of the phase indicator. The motor and generator are placed together with shafts in line and abutting, but not quite touching. The two machines must have the same number of poles, so that a revolution of the armature of each represents the same number of alternations. The abutting ends of the shafts carry two discs, one connected rigidly with the motor armature, the other similarly connected with the armature of the generator, as shown in fig. 1. In these discs are curved slits,



Figs. 1 and 3.

one slit for each pair of poles of the machines. These slits are shown in fig. 2 for an 8-pole machine. The two discs are in every way similar, the one being the reverse of the other. The two discs are practically superimposed, and together form one disc with four holes, where the slits of one disc cross over the slits of the other. Evidently the distances of these four holes from the centre depend upon the

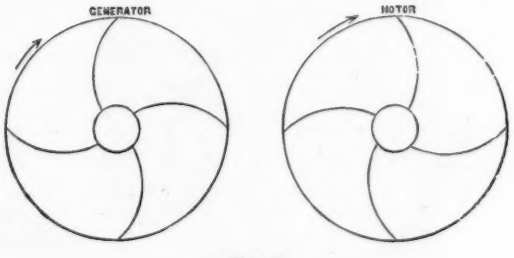


Fig. 2.

relative positions of the two armatures; they move in and out as the armatures shift their relative positions. From the symmetrical arrangement of the slits, if one armature is stationary and the other is moved past two pole pieces or through 90° of arc (corresponding to a complete period of alternation, or 360° of phase), the intersection of the slits will be the same distance from the centre as before. The curvature of the slits is such that the distance to or from the centre, that the intersections of the two sets of slits move, is proportional to the change in relative position of the two armatures.

When the two armatures are running at the same speed in the same direction, and there is a source of light on one side of the discs, the intersection of the slits, as seen from the

other side, appears as a continuous ring of light. A slight difference of speed causes this ring of light to move outward or inward, according to which disc is revolving the faster. The more rapidly the ring moves in or out, the greater the difference in speed of the two discs. If the ring is moving out, a new ring starts at the centre when one ring reaches the edges, and these rings keep following one another outward. If the difference in speed is the other way, the successive rings move inward.

In fig. 3 the heavy dotted line represents the ring of light for a particular position of the two discs.

The position of the ring of light indicates the relative position of the two armatures. The discs may be secured to the shafts, so that when the armatures are in the same positions with reference to the pole pieces (*i.e.*, the machines are in the same phase), the ring of light will be at the inner or outer ends of the slits. The concentric rings in fig. 3 represent the phase differences corresponding to positions of the ring of light in this case.

For convenience in operation, the arrangement of the apparatus, which has thus far proved satisfactory, has been as follows:—On one side of the pair of discs is placed an incandescent lamp, enclosed in a box. One side of the box is close to the discs, and has a slit in it about half an inch wide, extending from the shaft to the circumference of the disc. This slit is covered with a piece of oiled paper, so as to give a diffused light upon the discs. A complete ring of light is no longer seen from the other side, but only a small portion, corresponding to the width of the half inch slit. A stationary scale is fixed so as to extend from the shaft to the edge of the discs on the opposite side from the lamps, so that the distance of the changing line of light from the centre may be read so as to give the phase difference of the two machines by direct reading. To enable one to see the scale and line of light most conveniently, a mirror is arranged at 45° with the discs, so that the line of sight is at right angles to the shaft.

The discs may be arranged in the manner just described upon the abutting ends of the motor and generator shafts only in case the two machines have the same number of poles. Where such is not the case, one or both of the discs can be driven by gears, which will give the proper relative speeds of the two discs.

In operation, the instrument has proved quite satisfactory, giving exact and definite information concerning the changes in the armature lag of the motor. The fluctuations in this lag are usually quite marked, and the conditions which cause them can be readily investigated by this apparatus. For instance, this fluctuation is small with proper field excitation; as the field current of the motor is diminished, this fluctuation increases, the line of light moving rapidly back and forth through a greater and greater distance, which finally becomes so great as the excitation is weakened, that it goes a distance beyond which it cannot recover; *i.e.*, the motor gets out of step and stops. It would be possible to make a more detailed investigation of these fluctuations by means of a revolving mirror, and they may be photographed and made of permanent record by means of a moving plate.

The apparatus can be applied to other lines of work involving an investigation of phase differences and synchronism, and may be modified to meet the requirements of the problem in hand; but it is peculiarly suited for use in synchronous motor work, for which it was designed. The scope of the present paper admits only of a general description of the apparatus here given.

COOKING BY ELECTRICITY.

On Friday evening last Sir David Salomons and the directors of the City of London Electric Lighting Company, invited a number of the members of the technical and newspaper press, a sprinkling of the representatives of science, a few of the leading lights of the electrical industries, and the Lord Mayor of London, to a banquet at Cannon Street Hotel, where everything, from the sublime turtle soup to the ridiculous *petite pois*, had been cooked by electricity.

An excellent dinner it was, too, and one which drew forth the highest encomiums from the chief magnate of a city famous for sumptuous repasts. Moreover, the guests, about 100 in number, were privileged to inspect the process of cooking what was shortly to be served up to them, a privilege which would not so readily be granted by the hotel or restaurant proprietor in the ordinary way, nor probably, if granted, quite so much appreciated by the stray visitor allowed to pry into the mysteries of the kitchen.

So long ago as the year 1749, Benjamin Franklin, anticipating perhaps what was likely to happen nearly 150 years later, drew up a dinner *menu*, which, through the courtesy of Prof. Silvanus Thompson, we are enabled to append:—

Extract from letter from Benj. Franklin to Peter Collinson, dated April 29th, 1749.

Chagrined a little that we have hitherto been able to produce nothing in this way of use to mankind, and the hot weather coming on, when electrical experiments are not so agreeable, 'tis proposed to put an end to them for this season, somewhat humorously, in a party of pleasure on the banks of *Skuylkill*. Spirits, at the same time, are to be fired by a spark sent from side to side through the river, without any other conductor than the water, an experiment which we some time since performed, to the amazement of many. A turkey is to be killed for our dinner by the *electrical shock*, and roasted by the *electrical jack*, before a fire kindled by the *electrified bottle*, when the healths of all the famous electricians in *England*, *Holland*, *France* and *Germany* are to be drank in *electrical bumpers*, under the discharge of guns from the *electrical battery*.—"Experiments and Observations on Electricity" (Franklin). London, 1751, pages 34-35.

A daily contemporary, with the accuracy which generally characterises the newspaper press when dealing, or attempting to deal, with technical matters, states, after briefly referring to Franklin, that the honour and privilege of serving a banquet cooked entirely by electricity has been reserved to the City of London Electric Lighting Company in the year of grace, 1894. The company, however, must be contented with the knowledge that it has been forestalled, as the *Courrier de Londres* for June 9th has the following account of a dinner given recently by the Franklin Experimental Club of New York, on the first anniversary of its foundation:—"The banqueting hall was, of course, lighted by electricity, the guests were served with the various courses by means of a little electric railway, and the viands were cooked by electricity. At one end of the table was an automaton representing Benjamin Franklin, who phonographically welcomed the assembled guests, and who also made a speech after the first course. During the dinner, an acoustic apparatus placed near the ceiling entertained the guests with the Marseillaise, a speech of M. Eiffel's, and applause mingled with shouts of 'Vive la France! Vive la République!' All this was the reproduction of phonographic inscriptions registered nearly five years before at Paris, at the Universal Exhibition of 1889. On the appearance of each dish a fresh electrical surprise awaited the guests. It was electricity that had opened the oysters, boiled the eggs, heated the punch, made the coffee, &c. At the end of the dinner a rain of flowers covered the table. These flowers, attached to iron wires, had been held suspended during the dinner by electromagnets, and it was only necessary to break the circuit in order to bring them down. The guests left the table at the sound of a march played on the piano in a hall at Chicago, and transmitted by telephone with great purity and intensity."

Although probably every individual who participated in this homage to the "lightning catcher" felt higher than a kite, yet the entertainment provided by the City of London Company has a more serious import, for although without the side shows of the New York banquet, its significance cannot be misunderstood.

Electricity as an illuminant has slowly but none the less surely been coming to the front of late in competition with other forms of lighting, but it is only recently that the possible application of the current to cooking operations has attracted serious attention in this country, but it has now come to stay. Certain it is that the utilisation of electricity in this direction was a revelation to many gentlemen who were privileged to take part in last Friday's gathering, and expression of surprise and approval at the excellence of the cooking were heard on all sides.

In the kitchen, which was a carpeted room adjoining the reception room, were placed some five or six electric ovens raised above the floor on tables, and on an adjoining table were electric hot plates, electric saucepans, electric fish kettles, and other culinary necessities, all working by electricity.

There was no combustion, the heat being generated in resistances placed in enamel on the sides, top and bottom of the oven. Each side, together with the top and bottom, is separately regulated by a switch placed at one side of the oven. Thus it will be seen that no smoke or smell is given off, a state of things inseparable from oil, gas, or any other form of cooking appliance.

The apparatus used at Cannon Street was all supplied by Messrs. Crompton & Co., Limited, and the General Electric Company, precisely as illustrated in the Electrical Review article of September 29th, 1893, and the task of fitting up the apparatus was very ably carried out by Mr. Brydon.

Once having obtained the desired heat by the application of the current in all directions around the surfaces of the cooking chamber, it is "bottled up," so to speak, and, excepting the leakage, owing to no substance being absolutely non-heat conducting, we can keep it and turn it to whatever use we wish. There is no necessity for having a draught, as is the case with coal or gas fires, and consequently there is *no waste whatever* of heat, and, what is a very great desideratum, no carrying of the fumes and smell of cooking throughout the house or neighbourhood in which it is being carried on.

We well remember, when arc lamps were the only electric lights in existence, an apparatus to show the conservation of heat, effected by M. Didier, whereby he focussed the rays of the arc, and the heat carried by them, on a copper vessel some yards distant in which the object to be heated was placed, and surrounded this vessel with one larger and of similar shape, made of glass, and "bottled up" the heat until he got a sufficiently high temperature to distil spirit from wines, cook a chop, &c. The electrical oven conserves the heat in the same way, so that though the cost of current is distinctly high for the short time it is "full on," it is only wanted for a short time; but with a coal fire it is necessary to burn a large quantity of fuel in order to get the hot plate really hot, and also again to keep it hot, so that for every pound of coal put on one does not get more than the value of two or three ounces actually applied to the pot or pan we are heating.

The Yorkshireman says the rice will not be properly cooked if anybody stays at home from church on Sunday morning, but we dare say that a man may venture even to stay away from church, and bet on the rice being o.k., if he has an electrical stove.

In proposing, during the evening, "Success to the Development of Electricity," the Chairman (Sir David Salomons) remarked that, although the City of London Electric Lighting Company was formed ostensibly to put money into the pockets of the few out of the pockets of the many, the directors were animated with a desire to do good service to the public. They felt that the City of London should be served better than any other part of the globe, and before they had done they hoped that they would be able to accomplish the aim in view. Neither trouble nor pains would be spared to make the service thoroughly efficient. The company had supplied 97,000 lamps to the City authorities, apart from any supplied to the public. They often heard complaints of the tearing up of the roads; still, when he told them that 600 miles of wire had been laid down in some 40 streets, it would give them some idea of what the company had done during the period they had been in existence. Then it was said the cost of electricity was three times what was paid for gas. But they must remember that the light was three times as good, and he was sure none of them wished to go back to the old times. Only those connected with the company knew the uphill work they had had, but fortunately they were determined not to give in, and they none of them knew the meaning of the word impossible. He thought they would admit that the electric light had taken root and was growing in favour in all directions. On the present occasion they were the pioneers in a new direction, and electricity for cooking and heating purposes had been put to the test, and he trusted all present were satisfied that electricity would do all that was claimed for it. They had one thing to congratulate themselves upon, and that was the knowledge that the food they had partaken of was free from all gases. There was no taste of gas or coal in anything that had been placed before them that evening, although he did not contend that the cooking was everything that could be desired, which was doubtless due to the *chef* being unused to the system, an apology which was certainly not needed. They had been asked why they charged 8d. and 9d. a unit, while in the West End only 6d. was charged. His answer to that was the company was a young one, and that they only had five working days a week to seven in the West End. If their customers chose to live in the City they would be able to supply them as cheaply as in the West End. The directors, however, were prepared to charge only 4d. a unit where the electric energy was used merely for cooking purposes, and at that price they would compare favourably with that of any of the gas companies. Coming to the dinner given that evening, he found that the ovens erected for the occasion were capable of providing for 120 guests, while the number of units used was 60. Thus the cost per head was 2d. for 10 courses, of which the dinner consisted, but of course Sir David did not mean to imply that a dinner in a private house to a dozen or twenty guests could be cooked so economically as for a large gathering.

However, the demonstration by the City of London Electric Lighting Company proved beyond the shadow of a doubt the perfect adaptability of the electric current for culinary purposes. No fires have to be kindled, and much time occupied and coal consumed before they can be termed bright cooking fires; no heat is wasted when the process is over, as in ordinary ranges, nor, indeed, during the time the viands are in course of preparation, for it is concentrated wherever required, and can be regulated to a nicety; no smells except from the succulent food itself; no dust or dirt, but everything perfectly clean; no boiling over into the fire; a much cooler and purer atmosphere for cooks and scullery maids; no every-day cleaning of blackened cooking utensils of all kinds; in fact, all the vicissitudes and hardships under which *chef*, or good plain cook, have so long laboured, and which have tended to embitter their usually amiable tempers, are within measurable distance of being removed, and we trust that last Friday's diversion may be the means of an universal adoption of electricity for cooking, at least, in the houses of the wealthy, for it will prove an inestimable boon to cook, if not to policeman; and, perhaps, in the long run, taking everything into consideration and not merely comparing the cost of heat energy alone, cheaper than either coal or gas fires. Time only, however, will demonstrate this beyond any possible doubt.

THE FULGUR PRIMARY BATTERY.

We have had the pleasure of inspecting an installation of electric lighting at Manor Lodge, Acton, which is interesting from the fact that it is worked by a new primary battery, an improved form of Daniell's cell. Altogether 50 10-C.P. lights are fitted in the house, and the lighting was very effective.

The chief improvement in the cell is in the septum, which consists of a preparation of cork, somewhat resembling "Kamptulicon" floor cloth. How it is prepared is not at present disclosed, but the construction of the cell is very ingeniously designed for the proper circulation of the fluids and the supply of copper sulphate and water.

An element of success with a primary battery of this class lies in working it continually, for so long as current passes the zinc remains clean and the liquids circulate properly, but if the current is stopped for a time the liquids mix and copper sulphate gets into the zinc cell; it is, therefore, of importance to keep the current flowing all the time, and if the battery is to stand idle for any period to run off the solutions and fill up with water only.

To enable the battery to work at all times, a storage battery is used, and is divided into six sets, so that one set after the other is charged in succession from the primary battery, each set being charged once in every twenty-four hours for four hours. For the purpose of connecting and disconnecting at the proper times, an automatic switch worked by a clock is employed; this is a very elegant arrangement, is quite an ornament in the hall, and seems to perform its work well.

By these means and an arrangement of water-drip pipes and taps for a continually dripping supply of water, and a

drain pipe for draining off water and zinc sulphate, the battery works continuously, copper sulphate being shovelled in to each cell once daily in a measured quantity. The batteries require flushing out with water once a month, and are designed with a view to facilitate that operation.

What the actual cost per unit of electricity produced is we have not ascertained, but it goes without saying that it is much higher than dynamo current, but the expense is in many cases of no importance compared with the advantages of the electric light in decorated residences.

Running the battery continually and working from accumulators is a good system; with primary batteries its success, however, depends a good deal on the perfect operation of the automatic switch worked by the clock.

The whole combination is evidently well thought out and carefully carried into practice.

GAS ENGINE POWER FOR PRIVATE AND PUBLIC ELECTRIC SUPPLY.

By ED. C. de SEGUNDO.

At first sight it seems strange that gas engines are not used for the generation of electrical energy for electric supply, if not in central stations at least in substations. The gas mains are already laid, gas companies could afford to make a considerable reduction in price for gas so used, and the illuminating power of a cubic foot of gas when burnt directly is much inferior to the light produced in incandescent lamps, when the gas is consumed in an engine and the power thus developed is applied to driving a dynamo.

The fact remains that gas engine power is not largely used for public supply, nor is it largely used for private supply, except in cases where no other means exist of producing power conveniently. There must be a reason for this, and it may, therefore, be not uninteresting to enquire into the side issues involved in the use of gas power as against steam power for power generation at central electric supply stations.

Without touching upon the best theoretical form of gas engine, or the proper theoretical cycle, we may take as a basis for argument the best practical results attained at the present time in England, and we shall not be far from the truth in taking the Otto engine as manufactured by Crossley Bros. as being a fair representation of such results.

We understand that Messrs. Crossley are prepared to guarantee that their larger sized engines shall not consume more than 21 cubic feet of gas per brake horse-power per hour. Assuming a commercial efficiency of 92 per cent. for the dynamo, and, assuming that 10 per cent. is lost in transmission, we find that 21 cubic feet of gas consumed per hour corresponds to $\left(1 - \frac{1}{10}\right)\frac{92}{100} \times 746$, or 618 watt-hours, therefore $\frac{1,000}{618} \times 21$, or 33·3 cubic feet of gas corresponds to the production of one kilowatt-hour. Now this is undoubtedly a "best" result, and it is not likely to be continuously realised in practice. But this calculation shows that the figure mentioned in Mr. Dowson's recent paper on gas engine power, namely 40 cubic feet per kilowatt-hour, is a very fair one, and one, moreover, that may reasonably be expected to be attained in practice.

From this it follows that 1,000 cubic feet of gas may be considered to be able to generate $\frac{1,000}{40} = 25$ kilowatt-hours. The next point to determine is the number of candle-power-hours, corresponding to 25 kilowatt-hours. And here we are at once placed in a somewhat invidious position. The incandescence lamp manufacture has just been liberated from the thralls of a monopoly, and many wild ideas prevail as to the result of competition upon the efficiency, first cost, and cost of maintenance of incandescence lamps. That 4 watts per candle is an extravagant consumption is pretty certain, but it is not so clear at what limit of economy in watts per candle we are to draw the line corresponding to the maximum general efficiency. Thus a lamp yielding one candle-power for two watts has been spoken of, and, indeed, is being manufactured; but, so far, the experience gained of the working of such lamps is not sufficient to enable any authoritative statements to be made as to its practical value. In some former papers on a kindred subject, the author suggested 2·5 watts per candle as the maximum probable watt efficiency of the incandescence lamp, consistent with economy and efficiency in other directions. Within the last few months, the General Electric Company have issued a circular containing a table containing records of the Robertson lamp, said to be compiled from exhaustive tests. These figures point to 2·5 watts per candle being the efficiency at which the total cost of burning the lamp per hour, including renewals, is lowest. At three watts per candle the total cost is enhanced, owing to the life of the lamp not being proportionately greater to counterbalance the extra cost per hour for current by the diminution per hour in the proportion of cost of renewals. Below 2·5 watts per candle the converse holds, namely, the diminution in the life enhances the proportionate charge per hour for renewals to a greater extent than that in which the current cost is lessened.

In the following calculations it will be assumed, for the sake of argument, that one candle-power hour can be obtained at an expenditure of 2·5 watt hours.

On this assumption, then, we have 1,000 cubic feet of gas consumed in one hour in a gas engine, equivalent to

$$\frac{25,000}{2·5} = 10,000 \text{ candle-power hours.}$$

For the purposes of comparison, we must now arrive at the number of candle-power hours to which 1,000 cubic feet of gas, consumed per hour directly through the burners, will correspond.

It would be manifestly unfair to compare the performance of an incandescence lamp with that of an Argand or regenerative burner; therefore, the comparison will be made as between the incandescence lamp and the ordinary gas burner, and between Argand burners, and burners of that class generally, and electric arc lamps.

Ordinarily, it has been found that the average gas burner yields from 2½ to 3 candles per foot. But in order to be well within the results of good practice in gas lighting by ordinary burners, we will assume that 16 candle-power hours can be obtained from five cubic feet burnt in a good burner. This would correspond to

$$\frac{1,000 \times 16}{5} = 3,200 \text{ candle-power hours.}$$

With the new type of incandescence lamp, therefore, we may expect a very considerably greater efficiency of transformation of gas into light, although two intermediaries have been thereby introduced, the gas engine and the dynamo. These figures are, of course, not strictly proportional as representing practice, owing to the different conditions of transmission of the gas or electricity to the lamps, and for other reasons, which will no doubt readily suggest themselves to the reader. But it may be taken that with 2·5 watts per candle incandescence lamps, the difference in the illuminating power derived from gas burnt direct in burners and from gas used as a motive power for generating electrical energy is very considerable. It may be said that under the latter conditions they are about 2·5 times as efficient as the former.

The reason of this appears to be as follows:—When gas is burnt a certain amount of heat is liberated. But all the constituent parts of gas are not capable of combining with the oxygen of the air. Such portions, therefore, which have to pass through the flame carry away heat, instead of yielding heat by their combustion, and are worse than useless as means of illumination.

A distinction can also be made amongst the combustible portions. One class combines directly with the oxygen, others undergo dissociation before burning. One portion of the heat produced is thus carried away into the air by the inert gases, and by the products of combustion, a second portion of the heat is absorbed in producing the phenomenon of dissociation of the hydrocarbons, a third portion is utilised in heating to incandescence the particles of carbon liberated and held in suspension in the jet. These latter particles constitute nearly the whole source of luminosity. It is

necessary, in order to obtain a fair degree of efficiency, that the gas burner should fulfil the two following conditions :—

1. It must effect the decomposition of the hydrocarbons as completely as possible.

2. It must admit of the carbon particles being heated to as high a temperature as possible.

We are indebted to the late Professor Tyndall for the following figures relating to the absolute efficiency of a gas jet. He finds the illuminating efficiency of a gas jet to be 0·317 per cent., and the production of one candle-power requires an expenditure of energy at the equivalent rate of 68 watts. The corresponding figures for the incandescence lamp are 6 per cent. and 3·5 watts. (When these determinations were made the 2½-watt lamp was unknown.)

Mr. Emerson Dowson, in his paper entitled "Gas Power for Electric Lighting," also draws attention to this point, but the comparison made does not apply to present circumstances. He assumed that at 16 candle-power incandescence lamps required 55 watts. At that time, such an expenditure of electrical energy was considered inadequate to produce 16 candle for any length of time in any incandescence lamp used in England, but, on the other hand, Mr. Dowson assumed, in his anxiety to be fair when speaking of gas power, a consumption of gas per kilowatt-hour at the dynamo terminals which would appear to be much higher than the consumption to be reasonably anticipated from engines such as Messrs. Crossley Brothers are prepared to supply for central station work. He, moreover, compares the performance of incandescence lamps with that of an Argand gas burner; this, again, is not justifiable, but in spite of this electricity gains a victory over gas.

In a very interesting series of articles in *La Lumière Electrique*, M. Jules Bourquin makes a similar comparison. He takes 900 litres as the average performance of a gas engine per brake horse-power hour including the ignition flame, and he assumes 4 watts per candle as the efficiency of an average incandescent lamp. He takes the efficiency of the dynamo and distributing mains as 80 per cent., and arrives at 164 candle-hours as per result of consuming one cubic metre of gas in an engine, the candle-power being defined as one-tenth of the horizontal intensity of a carcel.

The performance of a cubic metre of gas burnt in gas burners direct he takes to be 91 candle-hours on the same basis of candle-power as before. The ratio of the two is

$$\frac{164}{91} = 1{\cdot}82.$$

Taking the best results which, we understand, Messrs. Crossley Brothers are prepared to guarantee, namely, 18 cubic feet of coal gas per brake horse-power per hour in their very large sized engines, and, assuming 80 per cent. efficiency of dynamo and line and 2·5 watts per candle as the efficiency of incandescence lamps, the respective quantities work out to

$$\left(\frac{1{,}000}{18} \times 746 \times \frac{8}{10}\right)\frac{1}{2{\cdot}5} = 13{,}200 \text{ candle-hours obtained}$$

electrically and $\frac{1{,}000}{5} \times 16 = 3{,}200$ candle-hours, or a ratio of 4·125.

This is an important result as suggesting a practical possibility. This figure, 4·125, can be checked by working in a different way.

A gas engine turns about 20 per cent. of the total heat of combustion into work. The mechanical efficiency of the engine may be put at 85 per cent., and the commercial efficiency of the dynamo (including loss in transmission by belt) 85 per cent. At 3·5 watts per candle the efficiency of the incandescence lamp is 6 per cent. or 8·75 per cent. at 2·5 watts per candle. The absolute efficiency of a gas jet is about 0 317 per cent.

The relative efficiencies then become—

$$\frac{\text{Gas burnt in engine}}{\text{Gas burnt direct}} = \frac{20\,\% \times 85\,\% \times 85\,\% \times 8{\cdot}75\,\%}{0{\cdot}317\,\%}$$

$$= \frac{1{\cdot}266}{0{\cdot}317}$$

$$= \text{nearly four times.}$$

It is, therefore, reasonable to say that it is practically possible to get four times the illumination out of a cubic foot of gas by consuming it in a gas engine and turning its heat energy into electrical energy, as by burning it direct in gas burners.*

This is a strong argument in favour of gas engines, but it is not the whole argument. It must not be forgotten that a gas engine is working, as it were, with prepared fuel, and the cost of preparation of that fuel must be taken into account. Also, although a gas engine may turn 25 per cent. of the heat into work that it is theoretically possible to turn into work, still the comparative efficiency of gas engines is inferior to that of a good steam engine. What we really should compare in the first instance is the actual cost of one brake horse-power hour. Now Messrs. Crossley advertise the statement that their engines will yield 1 brake horse-power hour at a consumption of 1 pound of anthracite in a Dowson gas-producing plant. There will always be a loss in transmission of power by belting of about 10 per cent., or considerably more if a countershaft is used. Hence the 1 pound of anthracite has to be augmented by 11 per cent., making it 1·11 pounds; this must be multiplied by the counter efficiency of the dynamo, say $\frac{1}{8}\frac{1}{7}$th per cent. = 1·27 pounds per horse-power hour at dynamo terminals. A Willans engine, coupled to a Siemens dynamo, works at a combined efficiency in practice of, say, 80 per cent. The engine will give one indicated horse-power hour at an expenditure of, say, 1·3 pounds of coal, equivalent to, say, 1·15 pounds of anthracite. The steam engine requires $1{\cdot}15 \times \frac{1}{8}\frac{1}{0}$, or 1·44 pounds for a similar output. The gas engine is, therefore, the cheaper of the two, the saving per horse-power hour being 0·17 pounds of anthracite, or say 0·2 pounds of coal. This amount of saving would make a difference of nearly 200 tons of coal per annum to a company having a very large incandescence lamp load.

Of course, efficiency is not the only factor to be considered in designing the plant for an electric supply station, but it is an important factor, and, other conditions being the same, would be a ruling factor.

Comparison on the Basis of Arc Lamps and High Candle-power Gas Burners.

This comparison presents some points of great difficulty, inasmuch as the accurate photometric measurement of high candle-power gas lamps does not appear to have received the same attention as that relating to arc lamps.

According to Messrs. Sartiaux and Weissenbruch (Report to Railway Congress in 1889), a Wenham lamp giving 179 candle-power consumed 25·43 cubic feet per hour, or at the rate of $\frac{179}{25{\cdot}43} = 7{\cdot}04$ candles per foot. A Wenham yielding 1,526 candles is stated to consume 153·6 cubic feet of gas per hour, or at the rate of $\frac{1{,}526}{153{\cdot}6}$ = nearly 10 candles per foot.

But according to the experience of the gas engineer at Liège the consumption in practice is not far short of 0·149 cubic feet per mean spherical candle-hour, or about 6·71 candle-hours per cubic foot.

The mean spherical intensity of the naked arc may be taken to be equivalent to about 1·81 candles per watt. But this, of course, is not the only consumption of electrical energy in arc lamps. A certain amount is absorbed by the additional resistance and by the feeding mechanism. A mathematical analysis of the conditions of working show that the stability of the arc increases with the amount of additional resistance, but, generally, it is found that an E M.F. of 65 volts is a sufficiently high one between the distributing mains on an arc lamp circuit where the lamps are taken off in parallel. Assuming the mean E.M.F. of the arc to be 47 volts (for an ⅛th inch arc, E, works out from the equation $39 + 70{\cdot}8\ l$ where l = length of arc in inches, to be equal to 47·8 volts), the production of one candle would there be enhanced in the ratio of $\frac{65}{47}$, and in order to ensure a fair diffusion of light it is necessary to surround the arc by a globe which absorbs a certain amount of light, hence it may be taken that 1 watt per effective candle is a fair performance for an arc lamp. Our basis of comparison is now a

* I understand that Mr. W. H. Preece, C.B., is stated to have given similar figures in the course of some remarks made recently in regard to electric lighting in Wimbledon.

Wenham gas lamp yielding 6·71 candles per cubic foot-hour and an arc lamp yielding one candle per watt.

In the course of the discussion on Mr. Emerson Dowson's paper, Mr. Kapp stated that at light load his gas engines at the installation at Madame Tussaud's exhibition consumed 36 cubic feet per kilowatt. As, however, the distribution loss is extremely small in such a case as this, it is only fair to add 10 per cent., which brings this consumption to nearly 40 cubic feet of town gas per kilowatt hour sold. Taking gas at 3s. per thousand cubic feet, the cost per hour of a 500 candle-power Wenham lamp would be $\frac{36}{1,000} \times \frac{500}{6{\cdot}71}$ or 2·68 pence per hour.

The cost of a 500 candle-power arc lamp would be $\frac{40}{1,000} \times \frac{1}{2} \times 36 = 0{\cdot}72$d. Of course some amount should be added to this for interest on plant, depreciation, &c., but all such charges should not amount to more than 0·7 pence per kilowatt hour, or 0·35 pence per 500 watt hour. Hence a very marked economy is shown in utilising gas in an engine to run arc lamps as against gas burnt directly in burners.

It is very difficult to take all considerations into account in determining the relative value of gas burnt direct, and gas used as motive power for an electric generating plant. In judging of the value of gas engines as substitutes for steam engines, regard must be had not only to their high thermal efficiency and to the points we have gone into at some length, but also to many practical matters, such as their efficiency under the extremely trying load conditions of a central station; their reliability in continuous work under these conditions. It would appear premature to give any definite statement of opinion as to what may be done in the future, having regard to the fact that manufacturers are by no means at one, either amongst themselves or with other engineers, as to the right cycle to adopt for an engine which is to work with a constantly varying load.

M. Jules Bourquin, to whose articles we have alluded before, has taken the trouble to reduce the total cost of a certain number of candle hours produced under the two conditions to an equation from which the equivalent number of arc lamps and Wenham lamps for equal total cost can be calculated. These equations, however, are not complete, and the results yielded are of necessity only approximate. But the method is novel and interesting, and we therefore quote some of his calculations here.

For the details of the various estimates we must refer our readers to *La Lumière Electrique* of January 13th and 20th.

He takes one 390-watt arc lamp as being equal in effective candles to three Wenham lamps of about 130 candle-power.

Then if x = number of arc lamps, $y = 3x$ will represent the equivalent number of Wenhams.

M. Bourquin finds that at Liège:

	Francs.
Gas for the engine, per annum, will cost ...	$86{\cdot}62\,x$
Interest on engine + depreciation	$29{\cdot}00\,x + 280$
Interest on dynamo + depreciation ...	$13{\cdot}88\,x + 52$
Loss in belt	 5
Water	$3{\cdot}57\,x + 31$
Oil	$0{\cdot}49\,x$
Switchboard depreciation	 50
Repairs	 300
Interest and depreciation on arc lamps ...	$16{\cdot}00\,x$
Carbons	$21{\cdot}85\,x$
Rent of gas meter	$1{\cdot}00\,x + 4{\cdot}45$
Rent of water meter	... ... 10 00
Attendant	... 1,200·00
	$172{\cdot}41\,x + 1{,}932{\cdot}45$

The cost of gas directly consumed in burners will be:

Gas	$131{\cdot}04\,y$
Interest and depreciation on lamps ...	$14{\cdot}50\,y$
Meter	$1{\cdot}06\,y + 4{\cdot}45$
	$146{\cdot}60\,y + 4{\cdot}45$

Now equating these totals and substituting $3x$ for y, will give a solution for x which will be the number of arc lamps at which the cost of electric illumination will equal that of gas. We find $x = 8$, and consequently $y = 24$, which means that if a shop or building requires more light than that yielded by 24 Wenham lamps of 130 candle-power each, it is cheaper to put down a gas engine plant and to run arc lamps than to use gas lamps. This is a result we would accept with much reserve, as we think that this limit of candle-power is too low, certainly for England.

REDUCED TELEGRAPH RATES BETWEEN INDIA AND EUROPE.

We understand that there is a growing feeling in Calcutta in favour of the reduction of the present rates to Europe. Early this year a paper was read before the Society of Arts on "Telegraphic communication between England and India." In this paper the author, Mr. E. O. Walker, C.I.E. (late of the Indian Telegraph Department), after referring to the fact that the revenue obtained from Indo-European traffic in 1891-92 was about the same as that for 1881-2, goes on to say:—"I am prone to think that the want of progress is rather due to the fact that there has been practically little reduction in cost per word for 20 years. I venture to assert that, in existing circumstances, looking at the dividends paid, the substantial reserves accumulated, the reduced cost of cables as compared with 20 years ago, and at the fact that the lines can carry a much larger traffic than they do, the public has a claim, and the companies, and the Governments of India and this country, have an interest in making Anglo-Indian telegrams cheaper. I would add that the Indian public ought to be relieved of fluctuating charges for the messages, made to depend upon the course of exchange. The charge can, and should be reduced by 6d. yearly, until the present rate (4s.) is lowered to 2s. 6d. This course would obviate any serious falling off in receipts. No guarantee by Government, nor by the commercial communities concerned, should be required to insure the companies against loss in taking this step. Their present position is sufficiently strong financially to admit of their incurring the risk."

The following extract from a letter since addressed by the Secretary of the Bengal Chamber of Commerce to Mr. Walker is also a strong impression of opinion regarding this subject: "1. That the rate for messages is high requires no demonstration. Unfortunately, the effect of exchange has been made apparent by an increase, within the past few days, of the charge per word to 3 rs. 7 as. *viâ* Persia, and 3 rs. 2 as. *viâ* Turkey. The difficulties of maintaining establishments and distance to be traversed are all allowed for, and yet the opinion is that the charge is a high one. 2. As to increase of traffic, the chamber believes that with a reduction of charge there would follow an increase in the volume of traffic."

Now, telegrams from India for Europe must pass either through the cables of the Eastern Telegraph Company or *viâ* the landlines of the Indo-European route. (In this connection we do not consider the Great Northern Company's system, which would only be called upon to carry this traffic should both of the above routes be interrupted). And, in view of a statement recently made by the chairman of the Eastern Telegraph Company to the effect that the Indo-European lines are "practically under the control" of the Eastern Telegraph Company, it is to be hoped that those interested in the monopoly thus indicated will see fit in the interest of all parties concerned to make the necessary reduction in rates, which, as pointed out by Mr. Walker, will bring its own reward in a corresponding increase of traffic.

Lighting by Oil, Petroleum, Gas, and Electricity.—It is important now that lighting is being made a special study, to be able to compare all the advantages and inconveniences of the different modes of lighting, and to do this numerous and complete documents are required. This comparison has been undertaken by M. Galine in a French work recently issued. He passes in review the principle of these various modes of lighting, and also the principal apparatus made up to the present day. In the last chapter he draws up a comparison, but there are, unfortunately, very few particulars as to cost.

CORRESPONDENCE.

Muirhead v. Commercial Cable Company.

Though it is with some diffidence that I venture to answer so eminent an authority on cable working as "F. J.," yet his letter in your last issue calls, I think, for some reply.

With the main body of my letter of May 11th he evidently agrees, as he only attacks a detail of an experiment therein described, and not the theory involved.

With regard to the question whether the experiment has or has not any practical bearing on duplex working, I can only refer to your leader of May 4th.

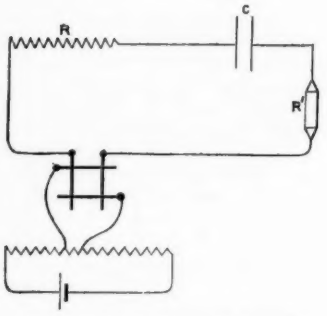
I was quite aware that under ordinary conditions the recorder signals would have been utterly unreadable, and had I sent you some of the first results I obtained, I fear your printers would have been in despair.

I therefore increased the speed of the tape somewhat, till a more legible record was obtained.

"F. J.'s" assertion that "the rounded form of signal is due to the shunt across the circuit in which is introduced the battery," is incorrect.

The resistance in the recorder circuit being large compared with that in the circuit shunting the cell, the P.D. between the points, *a*, *b*, was practically exactly similar to that due to a cell of low E.M.F. with no shunt.

However, I have repeated the experiment, using instead of the cell and shunt, a small P.D. due to a shilling and a penny with a piece of moist paper between. You will see



R, Resistance; C, Condenser; R', Recorder.

from the record enclosed that the results are identical with those before obtained.

By running the paper slower all the curves would become more Vd.

There would have been no *raison d'être* for my former letter had "all the results in question been so thoroughly threshed out ages ago" (and generally known) as "F. J." supposes.

In that case Mr. Bailey, and may I add, the writer of your leader, would have realised the importance of a low resistance in the condenser arms.

In fact, so small is the resistance required to be to give the necessary adjustment, that in practice the rheostat has sometimes been replaced by a short length of bare wire and balance obtained by sliding the earth contact up and down the wire.

A. H. Dykes.

Electric Lighting Specifications.

I would like to know, through the medium of your valuable paper, if any of your numerous readers have noticed a "comical" element in the modern specifications for electric lighting work?

I find that generally they are of little practical use to contractors, as the "schedule" only receives careful attention from either officers or men.

Briefly, two-fifths of the many clauses are only pedantic emphasis of a personal pronoun.

One-fifth is laboured enunciation of the elementary principles of the trade, and entirely unnecessary, because so well known.

One-fifth is composed of clauses which will not be repeated when the above-mentioned much emphasised individuals have acquired that peculiar knowledge which is alone the result of experience.

And the remaining one-fifth is composed of clauses which are generally erased, or reconstructed, as the aforesaid emphasised individuality gathers information and experience in the business by contact with practical men during the progress of the work.

Now, sir, it seems "comical" to me that contractors may not have a price consistent with the work to be done, and clients be bluffed into paying fancy prices for folios of what works out to be useless matter referring to the same job.

Specifications for electrical work may be a good medium for advertising unknown individuals; but the interests of the trade require more precise information regarding what is to be supplied and fixed for a definite sum of money.

And clients will be best satisfied when contractors receive their inspiration from the consulting engineers they employ.

An Installation Foreman.

Harpurhey, *June 16th*, 1894.

Portsmouth Central Station.

We have read with much interest the report of the "Portsmouth Corporation Works" in your issue of the 8th inst. It is, we believe, admitted by all that this plant as designed by Messrs. S. Z. de Ferranti shows great developments, and in many respects is novel and original.

May we, therefore, be permitted, through your valuable medium, to correct what appears to us a misprint in the detailed description of the "alternators." "Mica tubes" are therein mentioned. The insulation for this machinery was, however, supplied by us, and the word "mica" should read "micanite." You are probably aware that this insulator is a form of mica insulation, until introduced by us almost unknown in this country, or even Europe.

Since we claim by this patented process to be able, as in this case, to show infinite advantages over the old method of "mica insulation," we trust that you will give publication to this letter.

Thanking you in anticipation,

Bergtheil & Young.

P.S.—We write this with Messrs. Ferranti's sanction and approval.

Are Workmen Deteriorating?

I am afraid the true answer to the query you so ably illustrated in your last issue must be affirmative. The defective training, decreased social status, and the general environment of the modern workman, despite the increased facilities in the way of education, are accountable for this state of affairs. I served my apprenticeship as an engineer and wheelwright under a firm on the Surrey side, of historical reputation, and during my seven years passed successively through all the shops and the drawing office, the hours being from 6 a.m. to 6 p.m. I also learned two languages, in my somewhat limited leisure, to fit me for foreign service. The millwrights used to come to business in top hats and long-waisted frock coats, changing these for brown paper caps and overalls in the shops. These men were good mathematicians, could turn out a good working drawing and do anything in wood and metal, and when sent out to erect machinery were deservedly given full discretionary powers, to the advancement of the firm's reputation and financial position. In the fulness of time, under such good tuition, I also went out as chargeman with equal success. No "near enough" in those days, nothing but absolute perfection was admissible. The handling of the tools in no way detracted from one's social status, nor did it render us the worse as draughtsmen and mathematicians, and we required no supervision in the form of non-productive black cloth. In the present day things have altered; the workman is only a fitter or erector, and is invested with no discretionary powers, and the absence of responsibility causes him to be somewhat careless of results. Young "gentlemen" who have learned their trade (I beg pardon, their profession) by a listless saunter through the shops from 9.30 a.m. to 4.30 p.m., are placed in so-called charge, or are otherwise made to pervade the job, and between

their incompetence and the bad training of the irresponsible workman, bad work is done, and general dissatisfaction is the result. I am only 41 years of age, but am painfully aware that I am a kind of outsider in the trade I love, because I am too old to be "bossed" by boys, and have too keen a dislike for botchy work to suit the requirements of the present day; and so, like many of my contemporary tradesmen, am relegated in the prime of life to the ranks of the unemployed.

If the training of a working engineer is complete in the days of apprenticeship, and he is a sober and honest man, with an aptitude for grasping emergencies, he should be thoroughly responsible for his work on out-door jobs without supervision, and feeling this, a man with the spirit of a man will be jealous of the reputation of his employers, and will strive to accomplish everything in a perfect manner, not from the point of view that he is only paid to do so much, and the tools must drop directly the clock strikes, or the heavens may fall, but for honest love for, and pride in, his work.

Millwright.

PROPAGATION OF MAGNETISATION OF IRON AS AFFECTED BY THE ELECTRIC CURRENTS IN THE IRON.*

By J. HOPKINSON and E. WILSON.

Consider a solid, cylindrical electro-magnet, it is well known that, in reversing the magnetising current, the induction does not instantly reverse, but a certain time elapses before it again attains its full value, that it reverses at a later time at the centre of the core than near its surface, and that the delay in reversal near the centre is due to the electric currents induced in the iron. The object of the present paper is to investigate these effects.

The magnet experimented upon had a diameter of 4 inches, and formed a closed magnetic circuit. Through a part of its length the cylinder of 4 inches diameter was formed of an iron core, surrounded by two concentric, closely fitting tubes. Exploring coils of fine copper wire were bedded in the iron between the surfaces of the tubes. The currents induced in these exploring coils were observed when the current in the main coil of the magnet was reversed. These currents in some cases last for over half a minute.

Inferences can be drawn from these results as to the behaviour of other diameters than 4 inches. Comparing two cylinders of different diameters, similar events occur, but at times proportional to the squares of the diameters of the cylinders. From this consideration and the experiments, a judgment is formed as to the effects of local currents in the cores of transformers, and of the armatures of dynamo machines.

LEGAL.

Woodhouse & Rawson United, Limited.

Public Inquiry before Mr. Registrar Hood.

The London Bankruptcy Court was thronged early on Monday morning with persons interested in the history of the promotion, business transactions, and liquidation of this company, against which a winding up order was made on May 17th, 1893.

The following witnesses were in the list for examination, viz., Colonel Howard Vincent, C.B., M.P., Sir Albert J. Leppoc Cappel, K.C.I.E., Admiral Sir Leopold McClintock, Mr. Philip Rawson, Mr. F. W. Pixley, Lord Aberdare, Sir R. W. Rawson, Sir John Stokes, K.C.B., Mr. Samuel Pope, Q.C., Mr. F. L. Rawson, Mr. W. T. Stuchberry, Mr. Albert Hoster, Mr. T. H. Lambert, Mr. C. L. Baker, Mr. A. L. Foley, Mr. J. H. Owen, and Mr. Malcolm Dundas Mumford.

Mr. C. J. Stewart, Official Receiver, attended in person to conduct the examination; Mr. Muir Mackenzie and Mr. Geake appeared for Lord Aberdare; Mr. Jenkins for Sir John Stokes and Mr. Samuel Pope, Q.C.; Mr. Eve and Mr. Mossop for Mr. Philip Rawson; Mr. Kartnell for Mr. C. L. Baker; and Mr. Butcher, M.P., for other parties interested.

The statement of affairs filed under the winding up order showed a total indebtedness of £212,628 8s. 10d., of which £14,713 9s. 2d. was expected to rank, against assets valued at £44,349 17s. 5d., after allowing £166,482 17s. 10d. in respect of loans on debenture bonds. The account with the contributories showed a deficiency of £448,321 7s. 11d.

In commencing the proceedings, Mr. Stewart said the inquiry had been greatly delayed and great difficulty had been experienced in ascertaining facts, owing to the absence of a large number of original documents and books relating to the affairs of Woodhouse & Rawson, Limited, whose business was acquired by Woodhouse & Rawson United, Limited. He had made repeated applications to the liquidator of Woodhouse & Rawson, Limited, to the officers of Woodhouse and Rawson United, Limited, and to the receiver of the last-named company, but had been unable to obtain the documents and books in question. Under those circumstances he proposed to first call witnesses and ask a few questions on the subject, particularly with respect to the minute book.

Sir JOHN STOKES, K.C.B., said he was a director of Woodhouse and Rawson, Limited, and subsequently a liquidator. The books of the company were ordered to be destroyed by a vote of the shareholders after the liquidation was closed in or about last November. The winding up order against Woodhouse & Rawson United, Limited, was made on May 17th, 1893. Witness had not seen the minute book since the liquidation was closed, and had no idea whether it had or had not been destroyed.

Mr. F. L. Rawson, questioned by Mr. C. J. Stewart on the same subject, said he lost sight of the minute book of Woodhouse and Rawson, Limited, some time before the closing of the company. Although one of the liquidators of that company, he personally had nothing to do with the destruction of the books.

Sir ALBERT J. LEPPOC CAPPEL, K.C.I.E., was then called by Mr. Stewart, and stated that he was one of the original directors of Woodhouse & Rawson United, Limited, being appointed July 19th, 1889. He retired from office on August 1st, 1889, before the company went to allotment. Mr. F. L. Rawson approached him on the subject of becoming a director. At that time he was not acquainted with any of the other directors, and he had no interest in any of the companies whose businesses it was proposed to acquire. Mr. Rawson gave him a general impression that there were five companies being carried on separately, and that it would be desirable to band them together under one head. Those companies were Woodhouse and Rawson, Limited; Woodhouse & Rawson Electric Supply Company of Great Britain, Limited; Woodhouse & Rawson Electric Manufacturing Company, Limited; C. L. Baker & Company, Limited, and Woodhouse & Rawson Electric Contract and Maintenance Company, Limited. He understood that patents might be fostered and introduced to the public, one of the objects being the fostering of the patents; but he regarded it as an industrial business, with which the businesses of the other companies were to be absorbed. No actual information as to the financial positions of the various businesses was given him, but he gathered a general impression that they were all profitable, with the exception of the Manufacturing Company, and that that company would not be detrimental to the undertaking. Previous to the incorporation of Woodhouse & Rawson United, Limited, many meetings were held of the subscribers to the memorandum, &c., at which the proposed terms of purchase were discussed. A document was put in showing the patents at a valuation of something like £157,000. The attention of witness was drawn to a report and valuation by Mr. Edmunds. He said he understood that the valuation referred to in the prospectus was an independent one, and he was not aware that the actual wording thereof was drafted by Mr. F. L. Rawson.

Mr. Stewart: You knew that Mr. F. L. Rawson was largely interested in Woodhouse & Rawson, Limited?—Yes.

Then I take it you would have thought that Mr. Rawson, being in the business, might entertain a rather exaggerated idea of the worth of what he was going to sell?—If I had had that knowledge I should have left the place then and there, and have had nothing to do with it.

The Witness referred to some notes, and said it looked as if the Elmore patents were not to be included. He was not aware that the Elmore patents, which, apparently, were not to be taken over, were put down at something like £120,000, the effect being to reduce the £159,000 to about £39,000. He did not go into the question of arrangement, by which the lamps were to be manufactured and supplied at certain prices. The price to be paid for the businesses was £269,000, the goodwill being valued at £97,000, the stock at £29,000, plant £10,500, patents £85,500, and freehold property £47,000. He thought the goodwill was very good value. The accounts showed that the profits of the business of Woodhouse and Rawson, Limited, for the year ended June, 1888, were £21,440, and that they were estimated at £75,000 for the following year, ended June, 1889. Those representations were made to them by Mr. F. L. Rawson, therefore they were the representations of the vendors.

Cross-examination continued: He could not give any information as to the statements in the prospectus respecting the profits and prior dividends. He had seen the report, and had a general impression that it was somewhat qualified by the auditors' statement thereon. The prospectus was approved on July 19th, and ordered to be circulated, subject to Mr. F. L. Rawson satisfying the directors upon certain points. He remembered a statement that the profits were partly made up of shares in other companies.

Mr. Stewart: Did not that cause you to feel some doubts on the statements in the prospectus?—To a certain extent it did.

The witness's attention was drawn to Mr. Pixley's report, dated May, 1889. He could not say whether that report was read to him, but now thought that if it had he would not have been satisfied with the statements in the prospectus. Witness had no clear recollection of discussing the amount to be given for the goodwill, returned at £97,000.

Mr. Stewart: If you had been buying the business for yourself, would not you have gone into the matter very thoroughly and had the accounts audited by an independent accountant?

Sir Albert replied that he had no experience in company matters. He said the negotiations were very much rushed, and he began to have some feelings of uneasiness, and was determined not to proceed to allotment.

You were not satisfied with the amount of applications?—No.

Examination continued: On July 27th instructions were given to

* Abstract of paper read before the Royal Society, May 17th, 1894.

the broker to look into the applications and report thereon to the directors before they proceeded to allotment. Witness at that time had considerable doubts concerning the names of the applicants.

Mr. STEWART: It was entirely a question as to the amount subscribed that induced you to retire?—Yes; it was directly because there was not a sufficient amount subscribed. Immediately after the issue of the prospectus he began to look into the matter more deeply, and began to have doubts of the way the whole matter was being conducted. Upon his expressing his doubts of going to allotment, a meeting was held on July 30th, 1889, when a resolution was passed that, in view of the number of applications not being up to £200,000 —which was agreed as the minimum—the directors had decided not to proceed to allotment, and to return the sums deposited without delay. That resolution was carried with only one dissentient vote, given by Mr. Philip Rawson. A letter to the bankers was settled, and ordered to be sent, respecting the return of the application money. Immediately that decision was arrived at they were fired at by several legal gentlemen.

Examination continued: In spite of those letters, witness refused to withdraw from the resolution. The board adjourned, and reassembled at 4 o'clock the same day, when the letters having been read, it was agreed not to act at once on the resolution upon the understanding that a circular should be issued announcing the resignation of himself and of Colonel Howard Vincent, and of Sir John Coode, also of the withdrawal of their applications for shares.

Mr. STEWART: That was a way out of the difficulty, by which the company's monies should not be returned, but you would be allowed to resign?

Sir ALBERT explained that his reason for having the circular issued was that if anyone had been attracted to the company by his name, they would thus have an opportunity of altering their minds, which was actually done by some subscribers. It further appeared from the circular that Sir Leopold McClintock, Sir Rawson W. Rawson, and Mr. Samuel Pope, Q.C., had filled up the vacancies thus created, that further subscriptions for shares had been received, and that the allotment would be proceeded with.

Mr. STEWART: The three retiring directors were the only ones not interested in the company as vendors, I believe?

The question of the other directors' various interests was objected to by Mr. EVE, and was not persisted in by the Official Receiver, who eventually asked: "Were you aware that you were the only three directors entirely independent of the vendors?" and Sir ALBERT replied that it only came to his knowledge after they had refused to go on.

Mr. F. L. RAWSON next examined Sir ALBERT, who declined to describe himself as a telegraphic engineer of considerable experience and position, and as a gentleman able to form an opinion as to the value of the businesses. He agreed that it was originally contemplated to take over Woodhouse & Rawson, Limited, from such a date when the profits of the year were to be set aside as a guarantee fund for the benefit of the new company. Witness was unable to say whether the directors of Woodhouse & Rawson, Limited, objected to that course being followed on the ground that the new directors had taken a long time to investigate matters, with the result that the position had materially changed in the meantime. He did not recollect that the reason for having matters somewhat rushed was because it was necessary to have them settled before the Bank Holiday, otherwise they would have been delayed to the autumn. Nor could he remember telling Mr. Rawson that his sole objection to proceeding with the allotment was insufficiency of capital. It had been stated in his hearing that it could make no difference either morally or legally whether the minimum subscriptions were received by the day on which the lists were stated to be closed, or during the next three or four days. It was within his knowledge that no relationship existed between Mr. F. L. Rawson and Mr. Philip Rawson. Witness was not prepared to say that there were 30 or 40 drafts before the prospectus was approved. There were certainly one dozen drafts, and he took what he considered to be a great deal of trouble over the matter. Apart from the board meetings there were several meetings and conversations between Mr. F. W. Rawson and himself, Mr. Rawson trying to get the best terms on behalf of the vendors, and witness doing the same for the United Company. He signed some of the agreements between the new company and the different businesses to be acquired, and naturally insisted upon having the best terms obtainable. The valuation of Mr. Edmunds, dated April 12th, 1889, apparently included the Elmore patents then held by Woodhouse & Rawson, Limited, as such patents were not sold until the following June. He did remember that there was considerable value in Woodhouse & Rawson's lamp.

Examined by Mr. PILLING (Manchester shareholder), Sir ALBERT stated that he could not remember having seen balance-sheets relating to either of the five companies that it was proposed to amalgamate. He spent considerable time in looking into the company's affairs.

Mr. PILLING: And may I take it that the more you went into it the less you liked it.—You may take that. The more he looked into it, the more he found that it wanted greater scrutiny.

Colonel HOWARD VINCENT, M.P., was the next witness called to give evidence. Questioned by Mr. STEWART, he stated that he was approached by Mr. F. L. Rawson on the subject of joining the board of directors, and had previously known Mr. Rawson's father and brothers. Witness understood that it was to be entirely an industrial business. The prospectus sent out contained no reference to its being a financial business, and witness had no idea of its being contemplated to conduct any promotion of companies. He did not understand that a large proportion of the so-called profits of Woodhouse & Rawson, Limited, was simply *paper* profits That term conveyed to his mind the idea of imaginary profits. He knew that a portion of the profits was represented by shares.

Mr. STEWART: Which you considered to possess some value?—I agreed to put £5,000 into the company. That speaks for itself.

Examination continued: As a result of his investigations into the company's affairs, he began to have suspicions from the first that it had been promoted in an unbusiness-like manner. The minutes were not properly kept, and some considerable difficulty was experienced in obtaining information. He had placed reliance on the knowledge and experience of his colleagues, Sir Albert Cappel and Sir John Coode, and upon Mr. Rawson's family. When the reports of the valuer and auditor came to hand, he took them to be the work of loyal and honourable men, and consequently assented to them without reluctance. Mr. Pixley attended upon them before the issue of the prospectus. Witness saw the report after he had consented to act as a director. He was somewhat dissatisfied with the report, but was perfectly satisfied with the explanation afterwards given. The profits for the year ended June, 1888, he was informed, were £21,440, whilst those for the succeeding year were returned at no less than £75,000, which amount was available in cash, but would be held in reserve for three years. He was informed that was the case, but he agreed with the Official Receiver that underneath the statement in the prospectus bearing upon the profits the auditors' provisional clause ought to have been inserted. No light could be thrown by him upon the valuation of the patents, because he had been content to leave that in other hands, having the fullest confidence in Sir John Coode. Witness looked upon the lamp as being especially a valuable patent, and that was only one of a very large number of patents that were acquired. Although he was aware that Woodhouse & Rawson, Limited, had only been started two years before June, 1889, he understood that there had been a partnership between Messrs. Woodhouse & Rawson since 1881. When Mr. F. L. Rawson asked witness to take an interest in the concern, he told him that it had been a very great success indeed. He was not aware that a great bulk of the £75,000 returned as profits for the year ended June, 1889, was made by a successful transaction on the Stock Exchange, but he thought it might have had something to do with the Elmore shares. Taken generally, his objection was that as time went on he was less satisfied with the unbusiness-like character of the whole thing. He could not say anything more definite than that.

Mr. STEWART: In 1889, the assets of Woodhouse & Rawson, Limited, included a debt of £37,000, due by the Manufacturing Company, did they not?

The witness was unable to remember as to that point. He was exceedingly anxious that they should not proceed with the allotment until they had been to Manchester to make every enquiry, but the matter was hurried on. The proposition not to go to allotment unless £200,000 available cash was in hand came from witness and his colleagues before the issue of the prospectus.

Mr. MUIR MACKENZIE: When you allowed your name to appear you believed it was a good concern?—Well, I put £5,000 into it. He not only objected to the unbusinesslike character of the proceedings, but thought matters were unduly hurried on. In addition to which, he found that the business required more time than he could devote to it.

By Mr. JENKINS: His main reason for retiring from the board was because of the insufficient subscriptions to the company's capital. Other reasons existed in his mind, but they might have been only of an imaginary nature. He wished that persons who had probably subscribed on the strength of his name might have an opportunity of withdrawing should they elect to do so, and that opportunity was given them by the issue of the circular.

In reply to Mr. F. L. RAWSON, the COLONEL said that before calling in Mr. Pixley with regard to the profits, he went into the question with Mr. F. L. Rawson, but required confirmation from Mr. Pixley. He particularly wanted to have the £75,000 profits in available cash before the prospectus was issued. Up to the date of witness retiring from the company there had been only industrial transactions and no financial business of any kind. He certainly knew of no speculative Stock Exchange transactions, although he recollected some discussion respecting an application for the shares of the English Elmore Company.

Mr. RAWSON: Did I not give you all and every information?

Colonel VINCENT: You certainly were very active. He was of opinion, however, that they ought to have gone into details more than they did.

It has been suggested that I received £10,000 for the promotion of the Woodhouse and Rawson United Company. Was that so?—No one could suppose you were going to work for nothing. It never occurred to me that you would.

Mr. PIXLEY also examined the witness with regard to the provision in the report upon the profits of £75,000 for the year ended June, 1889, being subject to the realisation of a number of shares about the value of which he (Mr. Pixley) could express no opinion.

By the REGISTRAR: He was most favourably impressed by Mr. Pixley's report, and they confirmed the facts so far as they could in the limited time at their disposal.

The first witness called on Tuesday was **Mr. C. L. BAKER,** who, examined by Mr. C. J. STEWART, said he had formerly acted as managing director of C. L. Baker & Co., Limited, of Manchester. The amalgamation was broached to him by Mr. F. L. Rawson, who put forward the great advantages that would be reaped. Witness's company was doing fairly well at that time, and the shareholders were not altogether in favour of the amalgamation scheme; but upon its being pointed out that in the event of their standing out an opposition company would probably be formed, they decided to go in under the scheme. Witness understood that the various patents acquired by the company would be fostered, but he certainly had no idea that any manner of company promotion would be indulged in. The directors of C. L. Baker & Co., Limited, understood that a most satisfactory business would be carried on, or they would never have consented to the amalgamation. The purchase price for the business

of C. L. Baker & Co., Limited, was agreed at £24,000, payable as to £5,000 in cash, and £19,000 in preference shares. The goodwill of the business was valued at £9,000, the plant at £5,000, the stock at £5,000, and the patents and license at the remaining £5,000. The valuation was taken by an independent valuer, and was, if anything, under rather than over estimated. After the prospectus was issued witness heard from Mr. F. L. Rawson that, although there was sufficient capital to go to allotment, three of the directors, Sir A. J. Cappel, Col. Howard Vincent and Sir John Coode, who had set some particular figures to suit their own views, had refused to proceed to allotment, because their figures were not reached on the day the list was closed. Witness pointed out to Mr. Rawson that C. L. Baker and Co., Limited, would be seriously prejudiced if the allotment were not to proceed, and he should hold them responsible for any damage that might be sustained. Eventually a letter was sent to the directors by a solicitor on behalf of witnesses's company, but he was not aware that similar letters had been sent by the other companies whose businesses were to be acquired. The company, however, subsequently was started, and witness acted as manager of the Manchester branch, and that at Cadby Hall. He did not admit that he had the supervision of the practical part of the company's business. The nature of the business that had been carried on by C. L. Baker & Co., Limited, was that of electrical engineers, of which witness had 20 years' experience. He understood that the United Company agreed to pay £80,500 for the patents outside those belonging to C. L. Baker & Co., Limited, for which £5,000 was allowed. He no doubt thought at the time that the patents were a most valuable property, but his present opinion was that a lot of them were practically worthless. Asked to state which of the patents had realised anything, the witness said he knew that the switches and the lamps were valuable patents, especially until they were met with opposition. Had he been valuing the patents independently, he would probably have taken them at £20,000 or £25,000, and had the lamp patents been absolutely clear of Edison, the list would have been far more valuable. Witness was aware that there had been considerable difficulties with Edison, and although he understood they had been overcome, he now learned that such was not the case. The industrial business had resulted in a heavy loss for various reasons, but he was not in a position to say that such loss had amounted to £50,000. The witness was then questioned at some length respecting the circumstances under which the Kidsgrove business was acquired. He understood it would be a beneficial acquisition, especially for the manufacture of the heavy work; that it was earning £8,000 a year, and that the payment need not be made in cash. Assuming that was a *bona fide* business, he thought it would be a good thing for the shareholders, and was consequently in favour of taking over the business. Later he saw Mr. North, the business manager, who told him a different tale, and that he was not satisfied with those works. Next examined respecting his knowledge of Cadby Hall, the witness said when he first went there he felt he was almost regarded as an interloper. He found the state of affairs very unsatisfactory, and reported thereon in a letter to the directors, some of whom expressed surprise and in one case disgust. He also suggested in that letter methods by which that branch could be made a profitable business; but, as far as he knew, his suggestions were never acted upon. Some of the directors were on the works committee, and used to attend weekly at Cadby Hall, but he thought there was a great need for a guiding hand over the whole business, as, although Mr. F. L. Rawson was most active and attentive in the industrial business, he was evidently over-worked in other ways. He considered there was some difficulty in money matters throughout, although Mr. Rawson had always endeavoured to meet his requirements. Ultimately, funds could not be found for the payment of the weekly wages, and the bulk of the experienced hands were dismissed. The examination turned upon the statement of affairs, and witness was asked to give his opinion upon the depreciation, alleged to amount to £54,492, on the stock-in-trade, &c., which was thus reduced in value from £130,000 to £76,000. He thought, perhaps, that was partly caused by the demand not having equalled the supply, the result being that a large amount of the stock remained on the shelf. He knew very little about the manufacture of the lamps, as that branch was under the control of one man, and no one else was allowed to know anything about it. Shares in Woodhouse and Rawson United, Limited, were allotted to him in exchange for his business.

Mr. STEWART: Did you hold them at the date of the winding up order?—Certainly not.

You knew better than to hold them?—Certainly.

Examination continued: He had certain expenditure to provide for, and sold out his shares at prices considerably below par. The highest price he obtained for a £5 share was £3 12s., and the lowest was from 3s. 6d. to 7s. 6d. Later he thought prospects were brightening, and so purchased some ordinary shares on which £2 10s. had been paid. He gave £2 12s. 6d. for them, and eventually sold them for 10s. By March, 1892, he had sold out his entire holding. One of his reasons for selling was that he had invested money in Bell's asbestos; but, generally speaking, he was not satisfied with the prospects of the manufacturing business.

In reply to Mr. MUIR MACKENZIE, the WITNESS said the business of C. L. Baker & Co., Limited, was valued by Mr. Leeds, who was sent down for the purpose by Woodhouse & Rawson, Limited. He went to Cadby Hall in July, 1889, the date of his agreement with the company, but the final settlement did not take place until some months afterwards, and in the mean time one half of his salary was provided by his own company. When he started with the United Company he had no reason to doubt that it would be a very prosperous concern.

Mr. F. L. RAWSON also examined the witness, and elicited the fact that one of the reasons for consenting to the amalgamation was the fear that if they did not they would be met with opposition and competition by the new company. The name of Woodhouse and Rawson was well known all over the world for good work, and witness knew they would compete for the installation in Manchester. He had never heard a suggestion that Mr. Rawson's relations with the company were other than straightforward, and he had never known a company where fuller investigation was made into the accounts and business. A large amount of time and money was expended in getting the lamp patent into order, and had the arrangements been carried through with regard to the incandescent lamp, the company must have made a large amount of money over it. Opposition had been raised by Poole and White, who left them and set up for themselves, and who, by 1892, were serious competitors to the company.

Mr. RAWSON: The board did not consider them good enough to have charge of their important department.

WITNESS: The board never made a more serious mistake.

Asked respecting the Maskelyne typewriter patent, the witness said he regarded it as one of the best and most valuable patents in existence.

Examined by Mr. BUTCHER, M.P., who appeared on his behalf, the witness said the directors of C. L. Baker & Co., Limited, were not at all anxious for the amalgamation, but they had to study the interests of the shareholders, and thought it would be to their benefit to join the amalgamation scheme. The names of the directors inspired them with the fullest confidence, especially those of Sir A. J. Cappel, Colonel Howard Vincent, and Sir J. Coode. Witness acted as manager of the Manchester and Cadby Hall Works, but was never in any way general manager of the company.

At the rising of the Court for luncheon the missing minute book of Woodhouse & Rawson, Limited, referred to by the Official Receiver the previous day, was handed in to Mr. Stewart.

Mr. PIXLEY was next called. He stated, in reply to Mr. STEWART, that his company had acted as auditors to the company, and he (witness) had personally conducted the management of the audit. He had previously audited the accounts of Woodhouse and Rawson, Limited, and one of the subsidiary companies, known as the Supply Company. Messrs. Spain Bros. were the auditors of Woodhouse & Rawson previous to 1888, when witness entered upon the office. In May, 1889, he made a special report referring to the profit and loss account, showing a profit for the year ended June, 1888, of £21,440, which was referred to in the prospectus of Woodhouse and Rawson United, Limited. He added to the report a rider to the effect that it was obviously impossible for him to be responsible for the net profits, having regard to the nature of the assets and the company's interest in many trading concerns that had not yet been fully developed. He felt that they were profits that could not be treated as usually divisible. The report for the year ended June, 1889, was not made until May, 1890, probably on account of the company going into liquidation in the autumn of 1889. Mr. Stewart called the witness's attention to a letter written by his firm to the Supply Company, complaining that the audit was being delayed, and threatening that unless it was at once permitted they would have to take further steps in the matter.

Mr. STEWART: What steps did you propose to take?

The WITNESS replied that he was afraid that accountants could not take any further steps against companies to compel them to permit an audit. It was simply a bark without a bite.

The examination next turned upon the profits stated to have been made during the year ended June, 1889, the witness being taken through the items appearing in the balance-sheet as assets, and included by him in the report thereon. Asked whether he would have put that amount of profit in the prospectus, the witness replied that he would not like to take upon himself the responsibility of putting any figure as representing the net profits, and on that ground he sent a report with the balance-sheet. He saw a copy of the prospectus with his name appearing as auditor, and raised an objection to some of the statements therein, but was told that he could not object; in addition to which he could not then say that the assets would not realise sufficient to provide that profit. Some amusement was caused by Mr. Stewart holding up a printed book and remarking: "I see you have written a book on the duties of an auditor." He was proceeding to ask a question bearing thereon, when

Mr. MUIR MACKENZIE said, as one who had also written a book, he respectfully objected to the line of examination taken by the Official Receiver.

Further questioned by the OFFICIAL RECEIVER, Mr. PIXLEY thought it necessary that if an investor in Woodhouse & Rawson United, Limited, wished to form his own opinion as to the profits made in the past, he ought to have seen his report as well as the clause in the prospectus dealing with the past profits; but then, in his experience, investors never did form their own opinions. Questioned respecting the books of Woodhouse & Rawson United, Limited, witness said the books were not properly kept. The examination turned for a long time upon the duties of an auditor. Mr. Pixley said he was appointed by the shareholders, but he very much objected to the idea that he was to be a watch-dog on the directors. He pointed out that an auditor was only called in to audit past accounts, and could not possibly keep a watch over the directors' doings; but if he found anything wrong with the accounts, he would not pass them. After some further examination with regard to the balance-sheet of Woodhouse & Rawson United Company's trading to June, 1890, the Court rose for the day.

The inquiry was resumed on Wednesday morning, when Mr. F. W. PIXLEY again went into the box. In answer to Mr. STEWART, Official Receiver, he said that he should certainly not have passed any accounts which, in his opinion, were intended to mislead the shareholders. He did not know that their notice was anywhere called to the exceptional nature of the profits in the balance-sheet of June, 1890. It was the fact that these profits were not derived from the

industrial business, which showed a considerable loss, and that he (witness) urged upon the directors not to declare a dividend under the circumstances. The item of £109,597 returned as gross income in the balance-sheet of June, 1890, included about £17,000, being the amount of the premium paid for the lease of Cadby Hall by the Kensington Stores, Limited, which had been promoted by the company. He (witness) objected to this item being included in the profits of the year, but this course was adopted after the advice of counsel had been taken. The result of the transaction was certainly to create a large rental, and the capitalised value of this would have much exceeded the premium received. He did not think that the sale of the front of the premises would have the effect of depreciating the value of the plant upon them. He did not think that the profit returned on the sale of Elmore shares had been realised at the date of the balance-sheet. He had suggested to the directors that the income and expenditure in respect of the trading should be kept separate in the accounts from that connected with the financial operations of the company, but his recommendation was not acted upon. All the interviews which he had upon the company's affairs were with Mr. F. L. Rawson, the managing director. Mr. Rawson's view was that the profits should be kept up to the figure given, but he (witness) did not suggest that there was any intention on the part of that gentleman of placing them above their true value. Mr. Rawson, under his agreement with the company, was entitled to a commission of 25 per cent. in respect of surplus profits that remained after payment of 15 per cent. to the ordinary shareholders, and in the year in question he was thus entitled to about £13,000. This, however, was not received by him in cash, but was merely placed to his credit. He (witness) had some correspondence with Mr. Rawson as to the declaration of the interim dividend of 15 per cent. In his opinion, it was unusual that such a dividend should be declared before the accounts had been certified by the auditors. He did not see any prospectus after the original one, and he remembered objecting to one of them being issued with the name of his firm upon it. He had never held shares in any of the companies. He was present at the annual meeting held in May, 1890, but did not think his attention was called to the proposal to return the dividend guarantee fund. It was true that the existence of this fund was a great factor in inducing the public to apply for shares in the company. In the original prospectus it was stated that the profits of Woodhouse & Rawson, Limited, for the year ending June 30th, 1889, estimated at over £75,000, were to be deposited with the company for three years for the purpose of insuring the payment of a minimum dividend of 15 per cent. on the ordinary shares, after payment of interest on the debentures and preference shares. At the meeting of shareholders held on January 9th, 1891, it was stated that the retention of the fund was no longer necessary, and it was resolved to forego the fund in consideration of the vendors agreeing to forego the purchase money to the extent of £12,000. He (witness) was not present at the meeting, and did not think he knew anything about the matter at the time. His advice was certainly not asked by the directors as to the matter. The accounts for the year ending July, 1891, also contained several exceptional items, including a sum of £14,975, being assumed profit on shares in the Phœnix Trust Company. He (witness) knew nothing of the company at the time, but afterwards heard that it was promoted by Baron Grant. Originally only 25 founders' shares had been taken by the company in the Phœnix Trust, for which they paid £25. When the profit and loss account was made up, this asset was written up to the amount of £15,000, and the balance of £14,975 was carried into profit and loss. In October, 1891, witness wrote to Mr. Rawson, calling attention to various points in the accounts submitted to them which required explanation, and stating that his firm could not pass the accounts in their present form without appending a long explanatory certificate. In a subsequent letter he pointed out that the matters which had been complained of in the previous year had been materially aggravated in the present balance-sheet, and added that his firm felt that their responsibility in certifying the accounts would be a very heavy one. As the result of the correspondence, they informed Mr. Rawson that, unless the directors gave certain pledges, they would feel it their duty to append a special certificate, a copy of which they enclosed, and which was to the following effect: "We have examined the accounts of this company for the 13 months ending July 31st, 1891, and certify that, although they are practically correct as regards figures, yet they do not disclose the following facts to the shareholders. The gross profits referred to consist almost entirely of profits made on financial and not commercial operations, and are produced almost entirely by taking credit for values put upon shares in other companies promoted by this company, which are subject to realisation. The investments, consisting of £118,453, are composed exclusively of these shares and those of a private financial company working in connection with this company, while the shares in one of these companies, valued at £35,145, are only the property of the company by virtue of an agreement signed on July 31st, 1891. The sundry debtors include a sum of over £15,000 due from the managing director. Nothing has been written off the patents or the patent rights, and charged against profit and loss. In our opinion, the guarantee to the shareholders having been renounced at a special meeting convened for the purpose, no dividend should be paid in money until the investments already referred to have been converted into cash." As a matter of fact, the certificate was not appended, as Mr. Rawson represented to witness that such a course would depreciate the market value of the company's shares, and would be disadvantageous to its financial operations. As the result of the discussion, pledges were given by the directors that certain matters should be stated to the shareholders but he had not made any note upon the subject. It was certainly not on his suggestion that the financial business was extended to July 31st, to enable a profit of £35,000 to be shown in connection with the Epstein Company, which was registered on the last day of the financial year. It was the fact that nothing was written off in respect of the company's freehold premises, but, according to the directors' present statement of affairs, they had depreciated in value by £23,000. He did not attach any blame to the directors for not writing off anything in respect of goodwill, as he did not see how this could be done except through the profit and loss account.

In reply to Mr. JENKINS, the WITNESS stated that he knew the members of the board of directors as gentlemen bearing a high character, consequently he never had any doubt of their probity or uprightness; but he was of opinion that certain points in the accounts were not sufficiently amplified. The indebtedness of Mr. F. L. Rawson to the United Company was discharged by that gentleman assigning his claim against Woodhouse & Rawson, Limited, and surrendering his debenture stock in that company.

By Mr. F. L. RAWSON: He could not admit that it was the usual practice for directors to exercise pressure on auditors in order to get the audits completed.

At the rising of the Court the hearing was adjourned to Wednesday next, which day and the following one have been set aside by the learned Registrar for the further hearing of the case.

EDISON UNITED PHONOGRAPH COMPANY *v.* YOUNG.

IN the Chancery Division of the High Court of Justice, on Friday the 15th inst., the trial of this action came before Mr. Justice Romer. The claim of the plaintiffs was for an injunction to restrain the defendant from using, or exhibiting for use, any machine or machines made in infringement of the plaintiffs' phonograph or graphophone patents, and the other usual relief in a patent action.

Sir Richard Webster, Q.C., M.P., Mr. Moulton, Q.C., M.P., Mr. Bremner, and Mr. J. C. Graham, appeared for the plaintiffs; the defendant did not appear.

Mr. BREMNER, in opening the case, said that the plaintiffs brought this action against the defendant for infringing their letters patent, No. 6,027 of 1886, for the method of forming a sound record on the phonograph by cutting the record in the wax cylinder. The patent was a communication from America, and, as was frequently the case with American patents, it contained, in the first instance, a number of claims; but the patent was amended, and there were now only ten claims. The learned counsel then explained the operation of the phonograph, and read the specification. The importance of this invention, he said, was that it was the step by which the phonograph was converted from an interesting scientific toy into an article of practical use and value. Such improvements had been made that now the voice was given back distinctly, or the sound of a full orchestra in such a way that all the different instruments could be traced. The record of the cylinder was permanent, and could be used at any time by simply adjusting the machine and the reproducing point so as to fall into the record. In his answers to interrogatories, the defendant admitted what amounted to infringement of all the claims. The learned counsel then added that there had been very heavy litigation between the plaintiffs and the defendant, in which the defendant got the worst of it; but, of course, it was necessary for the plaintiffs formally to prove their case.

Mr. JAMES SWINBURNE, in reply to Mr. BREMNER, said that he had read the plaintiffs' specification, and found that the invention was therein properly and sufficiently described. In the defendant's answers to interrogatories, the machine described was the same thing as that described in the plaintiffs' first five claims. His attention had been drawn to some alleged anticipations, but there was no anticipation of any of the claims in the specification.

Formal proof was given of the plaintiffs' title, and

Mr. JUSTICE ROMER granted an injunction in the terms of the statement of claim, and an inquiry as to damages, made an order for the delivery up of all infringing articles in the possession of the defendant or under his control, and certified that the plaintiffs' had proved their breaches, and for a certificate that the validity of the patent came in question.

An application for costs on the higher scale was refused.

EDISON UNITED PHONOGRAPH COMPANY *v.* LOMAX.

IMMEDIATELY after the decision of the action against Mr. Young,

Mr. TERRELL appeared, and said that in the action of the Edison United Phonograph Company *v.* Lomax, an order was made that the action against Young should be treated as a test case, and that his client (Mr. Lomax, apparently) should be bound by Mr. Justice Romer's judgment. He (Mr. Terrell) asked that no steps should be taken against his client until he had had an opportunity of applying to Mr. Justice Chitty to set aside the order which had been made, and proceed to trial with the action. It was hard that he should be bound by the certificate in the action against Young.

Mr. JUSTICE ROMER said he had no power to do anything, except grant the plaintiffs relief.

NATIONAL TELEPHONE COMPANY *v.* MORRIS BROS.

AT the Sheffield County Court last week, Judge Ellison resumed the hearing of a case in which the National Telephone Company sued Messrs. Morris Bros., chemical manufacturers, Doncaster, whose works are at West Stockwith on the Trent, to recover £50 due for rent of a private wire. There was a counter claim by Messrs. Morris Bros. for £50 damages for alleged ineffective service of the telephone wire put up by the company between Messrs. Morris's office in Doncaster and their works at West Stockwith. When the case was previously

before the Court it was stated on behalf of Messrs. Morris that continuous complaints, extending over a period of three years, were made by them to the Telephone Company, while in addition 119 letters of complaint were written, and constant verbal complaints made. The Telephone Company, on the other hand, submitted that they repaired the telephone wire whenever necessary, and that they were therefore not liable for the damage claimed. The defendants' case on the counterclaim was reached at the first hearing, and last week plaintiffs, who are really the defendants on the counterclaim, presented their case.

After hearing at length counsel for both sides, his Honour reserved his decision.

NOTES.

Newcastle and Electric Lighting.—The Town Council have empowered the Special Committee to expend £200 in gathering information which can be relied upon regarding electric lighting.

Receipts of the Edison Company, Paris.—The total receipts of the Edison Company for May amounted to 209,761 francs, or 17,237 francs more than in the corresponding month of 1893. From January 1st to May 31st, 1894, the gross receipts amounted to 1,296,950 francs.

Automatic Compass.—M. Bersier, in *L'Ind. Elec.*, gives an account of his electrically controlled steering gear, which, being actuated directly from the compass, requires no "man at the wheel." The regulating device depends upon a spark passing from the needle to one or other of two metal points.

Safety Fuses.—Mr. Uppenborn has recently made experiments with fine fuses in vacuum tubes, with a view to preventing the loss of heat, and therefore to produce fusion with a small current. Manganin wire and tinfoil were used. In a vacuum they fused at between 0·17 and 0·2 ampères, whereas without a vacuum the ranges were from 0·19 to 0·23. The fuses are claimed to be serviceable for currents as low as 0·10 to 0·13 of an ampère. The article, which appears in the *Elek. Zeit.*, May 10th, is referred to in the N.Y. *Electrical World* "Digest."

Electric Light Mains in France.—Descriptions of the various modes of canalisation have frequently appeared, but there is one point of which little notice has been taken up to the present, viz., the official documents, decrees, circulars, and statutes, issued with regard to the electric mains. Messrs. Hérard & Sirey have collected all these documents, and they offer in a well-compiled volume all the official documents from the decree of April 30th, 1880, to the last instructions of the Prefect of the Rhone. We also find a very detailed study of all the resolutions of the Councils of the Prefecture, and the judgments given by a large number of tribunals. Information of this kind has, up to the present, been difficult to obtain; we think, therefore, it may be useful to call the attention of our readers to it.

Société Internationale des Electriciens.—The last sitting of the Société des Electriciens, which took place on June 6th, was presided over by M. E. Hospitalier, Vice-President. In the name of the Society M. Hospitalier congratulated M. D'Arsonval, who has just been elected a member of the Académie des Sciences. M. Rey then read a paper on "The Measurement of the Industrial Efficiency of an Electric Motor of 720 H.P." Several objections were raised by M. Hillairet. M. Hospitalier then presented M. Grassot's electrolytic meter, which is of great simplicity, and consists of a vertical silver wire, which falls by its own weight into a bath containing a solution of nitrate of silver. The passage of the current wears away the wire, which ends in a point and descends gradually, pulling a special gearing, which marks the expenditure. This meter can be bought at a very low price, which enables it to be employed for small installations. M. Larnande then read an exhaustive paper on "The Incandescence Lamp." He discussed in particular the progress accomplished, the present condition of the manufacture of the lamps, and made a few comparisons between the arc lamp and the incandescence lamp.

The Capacity of the Capillary Electrometer of Lippmann.—In a note by M. E. Bouty to the Academie des Sciences, it is stated that the initial capacity of mercury which has been some time in contact with acidulated water, is 140 microfarads per square centimetre.

Obituary.—So recently as September last we announced the death of Mons. J. Berly, who was well known to most of the electrical profession in London. We now learn with regret of the early decease of his widow, who died near Paris on the 14th of this month at the age of 47 years.

Carlisle and Electric Lighting.—From remarks made at the last meeting of the Town Council, it seems that electric lighting will not get a footing there for a long while. The Mayor and several members of the council are desirous of having it, but it is said that the local public are prejudiced against it.

Chester Electric Lighting.—After fully considering the matter, the Town Council last October resolved to purchase what is known as the Hop-pole Paddock for a site for an electric lighting station. On 13th inst., the Council decided to rescind that resolution, as a general desire has been expressed in favour of keeping the site as an open space for the public.

Dundee Electric Lighting.—Mr. Brownlee, the electric lighting engineer, has recommended that the works be extended by the introduction of a 200 H.P. engine with dynamo. At present the station has 660 H.P., and with the addition, there would be about 1,800 lights. This will be sufficient for the ensuing winter, but it is anticipated a further extension will be required in the succeeding year.

The Electric Light at Newport.—The electric lighting committee of the Newport Town Council has decided that the charge to consumers shall be as follows:—Under 1,000 units per quarter, 6d. per unit; above 1,000 and under 2,000 units per quarter, 5½d. per unit; and above 2,000 units per quarter, 5d. per unit. The committee has also decided that all the corporate buildings of Newport shall be lighted by electricity.

Alternating Currents and Fuses.—Recent investigations by Messrs. Jackson and Ochsner, of America, show that the change in resistance of fuse wires extending over a current period of 550 hours is practically negligible, and that we must look in other directions for the cause of the frequent blowing of converter fuses. The investigators briefly hint at the mechanical shaking to which converter fuses are sometimes subjected when not tightly clamped by the terminal screws.

Variable Speed Motors.—Mr. Baumgardt describes in the *Elek. Zeit.* a system to be used in factories and other places where motors are required to run at different speeds. Two generators, one of 100 volts and the other of 50 volts, are used; these are connected in series, a third wire from their point of junction makes a three-wire system. The field and armature circuits of the shunt motors may then be variously connected to these three wires, resulting in different speeds. Besides these combinations, resistances may be inserted in the field, thus producing intermediate speeds. This article is abstracted in the N.Y. *Electrical World* "Digest."

Cheltenham Electric Lighting.—Apparently this town wants things done at more than lightning speed. The Town Clerk signed a document on Monday, the 11th inst., and forwarded copies to two electrical papers, both published on Friday, the 15th, asking for tenders for cable for the corporation electric lighting scheme. He required £1 deposit to be sent to him, on receipt of which he would send a copy of his engineer's specification; this could not reach the intending competitor till Monday, the 18th. Then this energetic gentleman required the result of his enquiry to reach him on Tuesday, the 19th inst., thus giving the unfortunate tenderer say five hours to make his calculations and work out his quantities and prices. What conclusion can an ordinary mortal arrive at on reading this?

Southport Electric Lighting.—The price to consumers of current is to be 7d. per unit.

The Royal Society.—The following paper was down for reading yesterday afternoon: — "The Rotation of the Electric Arc," by Mr. Alexander P. Trotter.

Basingstoke and Electric Lighting. — Mr. Robert Hammond has been instructed to draw up a report regarding electric lighting for Basingstoke, at a fee of 25 guineas.

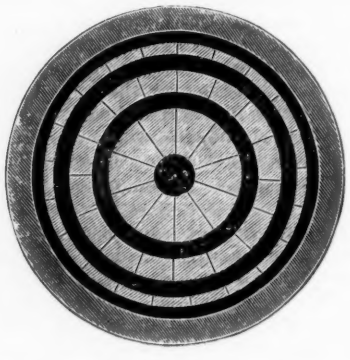
City and Waterloo Electric Railway.—The works of the new electric railway between the City and Waterloo Station have been commenced by the contractors, Messrs. John Mowlem & Co., of Grosvenor Wharf, Westminster.

College Electric Lighting.—The authorities of Wadham College have decided to have the College lighted by electricity, and the installation is to be completed by the time of the visit of the British Association.

Presentation.—The employés of the firm of Peto and Radford, Hatton Garden, presented Mr. William Peto, on Tuesday last, with a handsome silver salver, engraved with a suitable inscription, on the occasion of his marriage, on June 21st, to Miss Woodhead, of Newlands, near Huddersfield.

Electric Mains in Paris.—Electric mains are constantly being extended in Paris. The sector companies are to carry the mains through all the streets in their quarters for a certain number of years. The sector of the Champs Elysées has just been authorised by the Municipal Council to canalise the Avenue Wagram, the Rue Desrenandes, the Chaussée de la Muette and the Rue de Courcelles. The sector of the Place Clichy is authorised to canalise the Rue d'Edinbourg.

The British Insulated Wire Company.—At the recent dinner which took place at the Cannon Street Hotel, an account of which we give elsewhere, Sir David Salomons, who presided, emphasised his remarks somewhat by presenting the Lord Mayor with a sample of the triple concentric cable supplied by the British Insulated Wire Company for the mains



of the Supply Company, stating that this cable was used to "an enormous extent." The figure shows a section of the cable drawn to full size. The British Insulated Company's works are, we understand, full of work; they are rapidly making a name for themselves, which augurs well for their future prosperity.

The Nova Scotia Cable.—The steamship *Faraday* has picked up the Irish shore end of the Commercial Cable Company's third cable between Ireland and Nova Scotia, which was laid in April, and having spliced on the main, or deep sea, section, was on Tuesday paying out westward. The Commercial Cable Company have since received information that the *Faraday* paid out at noon on Wednesday 175·6 knots from the eastern splice, making a total of 316·7 knots from Waterville, Ireland, the position being lat. 51 44 N., long. 18 17 W. The weather was overcast, and there was a gentle breeze, but a heavy swell. It is added that the ship was then passing over the deepest water, and that all was going well.

The Electrical Banquet.—We are informed by Messrs. Crompton that 90 per cent. of the cooking apparatus used at the City Company's banquet last Friday was supplied by them, and their apparatus was almost exclusively used throughout the cooking operations.

NEW COMPANIES REGISTERED.

Dawson Gas Engines Syndicate, Limited (41,344).—This company was registered on the 12th inst. with a capital of £70,000 in £10 shares, to purchase certain inventions in the nature of engines to be worked by gas, petroleum oil, or other methods, and all the patent rights of Mr. H. T. Dawson, of 7, Upper Woburn Place, W.C., with respect of such inventions, and to carry on the business of mechanical, general, and electrical engineers. The subscribers (with one share each) are:—H. T. Crewe, 76, Queen Victoria Street, E.C., engineer; P. E. Singer, 19, Kensington Court, W., esquire; T. P. Gower, Broad Street House, E.C., gentleman; G. B. Woodruff, 24, Second Avenue, Hove, gentleman; H. T. Dawson, 7, Upper Woburn Place, W.C., engineer; C. D. Dawson, the Villa, Hythe, Hants, engineer; W. J. McCormack, 24, Warwick Chambers, W., secretary. There are never to be fewer than three nor more than seven directors; qualification, £1,000; remuneration not stated. The regulations of Table "A" mostly apply. Registered office 78, Queen Victoria Street, E.C.

Loanda Gas Company, Limited (41,343).—This company was registered on the 12th inst. with a capital of £50,000 in 4,000 preference and 1,000 ordinary shares of £10 each, to acquire the concession granted by the Municipal Board of the City of Loanda, in S.W. Africa, to Antonio Ayres Lourenço de Carvalho, and Dr. Alfredo Troni, approved by decree of the King of Portugal, for public and private lighting in the City of Loanda by means of gas, electricity, or any other system for a period of 50 years; and to supply gas and electricity for lighting, heating, and working machinery, or for telephonic and telegraphic purposes. The subscribers (with one share each) are: A. F. Baillie, 9, New Broad Street, E.C., merchant; A. Fairlea, 19, Grafton Square, S.W., civil engineer; W. F. Gordon, St. Edmund's, Denmark Avenue, retired Major; C. de Leopoldina, 3, Great St. Helen's, E.C., financier; G. D. Matthews, 32, Fordwych Road, N.W., civil engineer; F. A. Baird, 12, Grove End Road, N.W., mercantile clerk; T. W. Milten, 6, Monega Road, Gipsy Lane, Upton, E., clerk. There are never to be less than three nor more than five directors; qualification, £200; remuneration £350 per annum and percentage. Registered office, Dashwood House, New Broad Street, E.C.

F. H. Royce & Company, Limited (41,362).—This company was registered on the 14th inst. with a capital of £30,500 in £1 shares (30,000 ordinary and 500 deferred) to purchase the business of Frederick Henry Royce and E. A. Claremont, now carried on under the style of F. H. Royce & Co., at Cooke Street, Hulme, Manchester, and to carry on the trades of manufacturing electricians and mechanical engineers. The subscribers (with one share each) are:—F. H. Royce, Eastbourne, Chorlton-cum-Hardy, electrical engineer; E. A. Claremont, Electron, Chorlton-cum-Hardy, electrical engineer; A. W. Claremont, 4, Bloomsbury Square, W.C., solicitor; J. De Looze, Attleboro Terrace, Dean Lane, Moston, clerk; E. Claremont, Chorlton-cum-Hardy, married woman; M. G. Royce, Chorlton-cum-Hardy, married woman; F. Himus, 6, Sidney Villas, New Malden. There are never to be more than four directors; the first managing directors are Messrs. F. H. Royce, and E. A. Claremont, and their remuneration is to be £400 per annum each. Qualification of an ordinary director, £250 at least; but this does not apply to the two gentlemen just named. Registered by Haynes & Claremont, 4, Bloomsbury Square, W.C.

Hemming & Co., Limited (41,341).—This company was registered on the 12th inst. with a capital of £25,000 in £5 shares, to enter into a certain agreement for the acquisition of the business of T. L. Hemming & Co., Limited, of 88, Snow Hill, Birmingham, and to carry on the business of mechanical, chemical, electric, scientific and

general engineers, electricians, founders, iron, steel and bronze workers, manufacturers of motors, dynamos, &c., &c. The subscribers (with one share each) are:—S. Tonks, Hagley Road, Birmingham, gentleman; J. Thornton, Claremont Road, Handsworth, drysalter; T. L. Hemming, Wheeler Street, Birmingham, manufacturer; T. R. Canning, Great Hampton Street, Birmingham, drysalter; S. Curtis, 84, Bull Street, Birmingham, merchant; J. Ryland, Aston, brassfounder; C. T. Bishop, 31, Wheeleys Road, Birmingham, manufacturer. Messrs. J. Thornton, T. L. Hemming, S. Tonks, C. T. Bishop, and T. R. Canning are to be the first directors; qualification, 20 shares; remuneration not stated. Registered office, 88, Snow Hill, Birmingham.

Ronald A. Scott, Limited (41,372).—This company was registered on the 15th inst. with a capital of £10,000 in £1 shares, to purchase the business of Ronald A. Scott, of Acton Hill, W., and to carry on the business of electricians and electrical engineers. The subscribers (with one share each) are: R. A. Scott, The Elms, Acton Hill, W., electrical engineer; A. Scott, The Elms, Acton Hill, W., married woman; G. Wolley, 15, Hyde Park Mansions, W., engineer; G. Heaver, 15, Salcott Road, New Wandsworth, S.W., clerk; G. H. Garratt, 12, Grove Park Gardens, Chiswick, W., electrical engineer; T. H. J. Watts, 3, The Ravenscroft, Cumberland Park, N.W., electrical engineer; T. Darner, 3, Marsden Road, E., Dulwich, clerk. The first manager is Mr. R. A. Scott. Registered office: The Elms, Acton Hill, W.

Llandudno Electric Supply Company, Limited (41,382).—This company was registered on the 18th inst. with a capital of £15,000 in £10 shares, to carry on within the district of the Llandudno Improvements Commissioners the business of an electric supply company in all its branches. The subscribers (with two shares each) are:—R. Conway, 112, Mostyn Street, Llandudno, ironmonger; J. Bellis, Bronhulog, Llandudno, rate collector; J. Smith, Craigside, Llandudno, manager; J. Nicol, Warwick House, Llandudno, physician; W. E. Jones, 76, Mostyn Street, Llandudno, draper; W. R. Nichol, Oakleef House, Llandudno, physician; W. Arnold, 83, Mostyn Street, Llandudno, draper. Registered by Kennedy & Co., 1, Clement's Inn, W.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Priestman Oil Engine American Syndicate, Limited (30,063).—This company's last return was filed at Somerset House on April 20th last. It shows that out of a nominal capital of £25,000 in £10 shares, 2,450 shares have been taken up, and that the full amount has been called. A sum of £12,000 has been received in response to calls, and £12,500 has been agreed to be considered as paid.

South of England House-to-House Electricity Company, Limited (29,233).—This company's yearly return, filed at Somerset House on May 9th, 1894, shows that out of a nominal capital of £100,000 in 19,900 ordinary and 100 founders' shares, all of £5 each, 107 shares have been taken up. Nothing has been paid; but £500 has been agreed to be considered as paid on 100 shares.

Metropolitan Electric Supply Company, Limited (25,395).—This company has filed its annual return, which was made up to the 7th of last month. It shows that out of a nominal capital of £500,000, in 49,900 ordinary and 100 founders' shares, all of £10 each, the whole of the shares have been taken up, and that £10 has been called on 47,868 ordinary shares, and the full amount issued as fully paid on 2,132 shares of the same class. A sum of £478,421 9s. has been received in response to calls; £21,320 has been agreed to be considered as paid; £258 11s. is outstanding; and £61 9s. is the total amount paid on 32 forfeited shares.

Phonopore Company, Limited (25,480).—This company (formerly known as the Phonopore Syndicate, Limited) has just filed its annual return, which is made up to May 14th last. It shows that out of a nominal capital of £150,000, in 100,000 ordinary and 50,000 preference shares, all of £1 each, 90,000 ordinary and 28,343 preference shares have been taken up. There has been 15s. called on each of 17,963 preference shares, and the full amount on 20,975 ordinary shares. The total sum received is £34,798 10s.; £79,405 has been agreed to be considered as paid; and £4,139 10s. is still outstanding.

Southampton Electric Light and Power Company, Limited (26,354).—This company's yearly return was filed a few days since, and shows that out of a nominal capital of £30,000, in 4,000 preference and 2,000 ordinary shares, all of £5 each, 50 preference and 708 ordinary shares have been taken up. The full amount has been called, £3,735 has been paid, and £55 is still outstanding.

Manlove, Alliott & Co., Limited (27,648).—This company's yearly return, filed on the 28th ult., shows that out of a nominal capital of £100,000, in £10 shares, 4,399 shares have been taken up, and that the full amount has been called and paid on 53 shares. The sum of £43,460 has been agreed to be considered as paid, and £2,000 has been agreed to be considered as paid on 200 shares forfeited.

Kennedy Storage Battery Company, Limited (37,063).—This company's yearly return, filed March 22nd last, shows that out of a nominal capital of £100,000, in £1 shares, the whole has been taken up, and agreed to be considered as fully paid.

China and Japan Telephone Company, Limited (17,831).—This company's yearly return, filed on the 22nd ult., shows that out of a nominal capital of £20,000, in £1 shares, 14,761 shares have been taken up, and agreed to be considered as paid.

Automatic Electric Railway Signal Company, Limited (37,636).—This company's yearly return was filed on May 19th last, and shows that out of a nominal capital of £10,000, in £1 shares, 490 shares have been taken up, and that 15s. has been called on each of 1,605 of these. The sum of £1,010 has been received in response to calls, £3,300 has been agreed to be considered as paid, and £193 15s. is still outstanding.

African Trans-Continental Telegraph Company, Limited (37,855).—This company has just filed its first annual return, which has been made up to the 24th ult. It appears that out of a nominal capital of £140,000, in £1 shares, 75,436 shares have been taken up. The full amount has been called on 1,296 shares, and 5s. on each of 74,140 shares. The total received is £19,581; and £250 is outstanding.

Eastbourne Electric Light Company, Limited (16,422).—On April 26th this company filed its annual return, which shows that out of a nominal capital of £50,000, in £10 shares, 1,017 ordinary and 40 preference shares have been taken up, and that the full amount has been called and paid in full. The sum received is therefore £10,570.

Baily, Grundy & Barrett, Limited (38,004).—This company filed its yearly return on the 6th inst. It shows that out of a nominal capital of £10,000, in £5 shares, 662 shares have been taken up, and that the full amount has been called on each. The total received is £3,300, and £10 is outstanding.

Fowler, Lancaster & Co., Limited (40,344).—This company has just filed its annual return, which shows that out of a nominal capital of £50,000, in £10 shares, 554 shares have been taken up. The full amount has been called on 54 shares, and £5 on each of 500. The sum received is £3,040. The registered office of this company is now at Albert Works, Graham Street, Birmingham.

Electric Wiring and Fittings Company, Limited (29,676).—May 1st, 1894, is the date on which this company filed its yearly return, from which we learn that out of a nominal capital of £5,000 in £1 shares, 1,382 shares have been taken up, and that the full amount has been called on each. The total sum received is £1,375, and there is £7 outstanding.

Albert Electric Lighting Company, Limited (34,134).—This company filed its annual return on May 8th last, from which it appears that out of a nominal capital of £10,000 in £5 shares, 407 shares have been taken up, and

that the full amount has been called on 400 of these, and £1 on each of the remaining seven. The sum received in response to calls is £2,007.

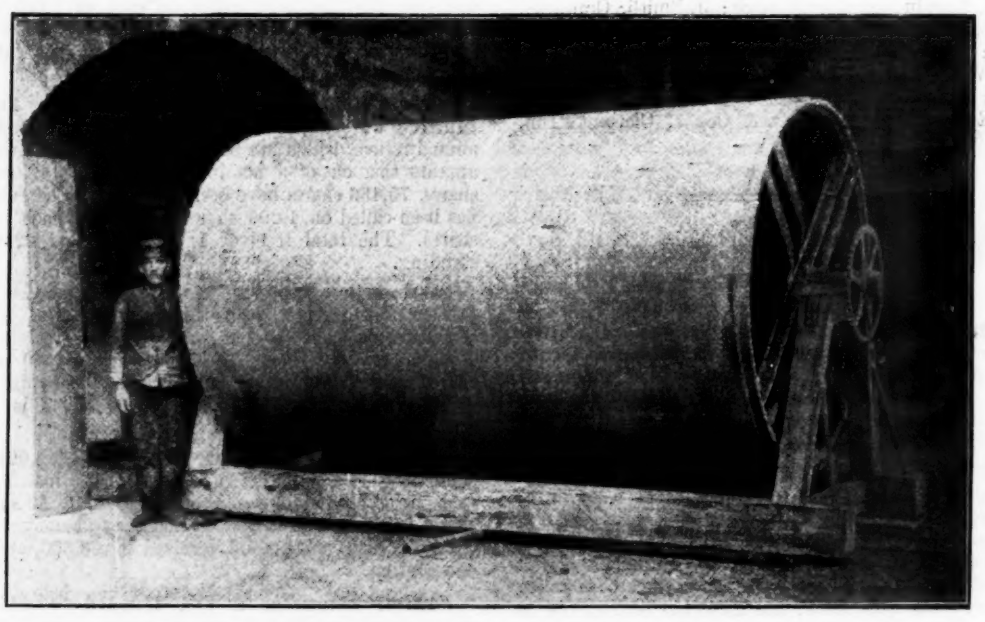
Charing Cross and Strand Electricity Supply Corporation, Limited (29,122).—This company's return for the year, filed on March 8th last, shows that out of a nominal capital of £150,000 in £5 shares, 30,000 shares have been taken up, called, and fully paid.

Evered & Co., Limited (20,158).—This company's yearly return was filed on the 4th inst., and shows that out of a nominal capital of £200,000, in £10 shares, 16,496 shares have been taken up, and that £10 has been called on each of 6,744 of these, and £7 on each of 9,752. The total received is £135,704.

London Electric Supply Corporation, Limited (24,957).—This company's yearly return was filed on the 5th inst., and shows that out of a nominal capital of £1,250,000, in 200,000 ordinary and 50,000 preference shares, all of £5 each, 111,000 ordinary and 48,050 preference shares have been taken up, and that the full amount has been called on each. The total received is £798,990; and £3,740 has been paid on 1,950 forfeited shares.

BUSINESS NOTICES, &c.

A Large Elmore Tube.—The illustration is taken from a photograph taken at the factory of the German Elmore Company at Schladern, near Cologne, Germany. The tube represented is said to be the largest seamless copper tube in the world, and was manufactured for a firm of machine makers in Switzerland. The tube, which is 7 feet in diameter by 16 feet long by 5 mm. (¼-inch) thick, was of perfect finish when taken from the bath or tank in



which it was deposited, and required no turning or trueing of any description. The company, which has made the manufacture of large diameter tubes a speciality, propose to make a still larger tube for the same firm, namely, 8 feet in diameter. The company is exhibiting at the Antwerp Exhibition, where cuttings from the above tube and samples of their other productions can be seen.

Gas and Electricity.—The thirty-first annual general meeting of the Incorporated Gas Institute was held on Tuesday at the Westminster Town Hall. Mr. John West, in his presidential address, pointed out the different positions generally held by gas undertakings compared with 25 years ago, and alluding to the extension of the use of gas for heating, he said the consumers had certainly shown, by their adaptations of the means offered, that the privilege of cooking and heating by gas, after being put before them in a practical manner by gas companies, had been accepted in a most remarkable manner throughout the country. It had been pointed out that they now had two very honourable competitors in the field; he referred to the electric light and the various cheap light-giving oils that were now in the market. He looked upon this state of things as a very probable means of bringing gas undertakings and all connected with them to the forefront, and it would ultimately be the means of bringing out the latent talent in the gas industry. A number of the general public did not seem to be aware that the electric light was produced chiefly from the same source as they produced light—viz., from coal. They utilised the energy in the coal more completely, in a commercial sense, than the electrician could; and this enabled them to produce a given quantity of light from gas from three to three-and-a-half times cheaper than the price for which the equivalent electric light could be sold so as to produce the same profit that was being derived from the manufacture of gas. If some of the public liked to pay for the electric light as a luxury, there was no doubt that installations within reasonable areas, with gas engines as the motive power, will be found the most reliable and economical, and, from a sanitary point of view, far better than the large number of steam boilers that were being put in our midst for the purpose. It was now a well-known fact that a gas main would deliver sufficient gas to generate 5,000 horse-power, or as much more as they pleased, at a long distance—say, three or more miles—at from three to four times less than the same power could be transmitted for by electric cables. Again, the load factor was a great drawback to the electricians. They could not store their energy as they did in gas holders; hence their fuel account came out very high per unit produced. In many cases, they used the best boilers and steam engines; and they would say that they could produce, with 2½ lbs. to 3 lbs. of coal, one Board of Trade unit. In practice, however, if they looked at the accounts of the electric light departments, they would find that they had, in some way or other, used in many cases about 12 lbs. of coal per unit; and how to get over this difficulty had been taxing the brains of electricians for a long time. He found, from calculations, that the Gaslight and Coke Company delivered from Beckton to London—a distance of seven miles—through only two of their mains, sufficient gas per hour to produce, in ordinary gas engines, about 125,000 horse-power, the power expended in transmitting this quantity being less than one-quarter per cent. of the total. It would be interesting to know the cost of an electric cable to convey this power the same distance, and the loss in transmission.

Edinburgh Electric Lighting.—We learn that the estimates for the new electrical station at the West End have been received, and that the lowest amounts to £18,000, which is £8,000 above the prospective estimate laid before the committee by the Burgh engineer.

Montrose and Electric Lighting.—The Police Commission have resolved to negotiate with certain electric lighting companies with a view to ascertaining the terms on which an installation could be carried out at Montrose, either under a provisional order obtained by the Board, or by a company with the consent of the Board.

Electric Light for Shoreditch.—We hear that the vestry of Shoreditch have decided, by a narrow majority, to purchase what is known as the Pitfield Street site, Hoxton, for the erection thereon of an electric lighting station, baths and wash-houses, and dust destructor. The price agreed upon is £33,500.

Aberdeen Prisons and Electric Lighting.—The Watching Committee of the Town Council have recommended that the new prison buildings at the Police Barracks be lighted with electricity. The fittings are estimated to cost £150 more than the fittings for gas lighting.

Woking Electric Lighting.—The Sanitary and Lighting Committee have resolved to write a letter to Messrs. New and Mayne asking what guarantee they could give if they obtained the lighting contract.

Barnet and Electric Lighting.—Barnet ratepayers are not very anxious to have the electric light introduced. 315 ratepayers were circularised on the subject with the following result: 37 ratepayers were favourable to the light but would not sign the agreement; 26 were undecided; no reply was received from 35; and 19 were not at home. The collector's report stated that a large number of the occupiers declined to have anything to do with the matter of electric lighting on the ground that its adoption might involve the district in considerable expense and so increase the General District Rate. Other ratepayers asked that the matter should be postponed until after the election of the District Council; they thought it should form one of the questions on which the election should be fought. Many of the ratepayers agreed as to the badness of gas and to its high price. But they stated that as they had already been put to considerable expense in providing gas fittings they were not inclined to spend further sums in electric lighting appliances. It had been suggested by several ratepayers that the Board should fit up the houses with the necessary appliances and charge a rent. A letter was received by the Local Board from the Brush Company, dated May 10th, offering to give further information. A letter was also read from Messrs. Crompton and Co., to Mr. Morse, in reply to a letter addressed by that gentleman to the company. It was as follows: "Dear Sir,—In reply to yours of the 25th May. The time you give us is too short to say further to-day than that Mr. Albright and myself, as managing directors, are agreed that we should be quite prepared to recommend to our board the acceptance of the general principle of undertaking for a period of years the risk of running, without any guarantee, the local authority finding the necessary capital. Of course there are many details of such arrangements as these which would require careful consideration, and we should be glad if the Local Board of Barnet accept the general principle, to meet you, or any member of your committee to discuss such details.—Crompton Company, Limited, R. E. Crompton, Managing Director." The Committee recommended that the Board accept the principle as set out in Messrs. Crompton's letter, and that negotiations be opened with a view to a scheme being submitted to the Board at a subsequent date. Mr. Walker moved, and Mr. Clarke seconded, the adoption of the report. After considerable discussion, however, the following amendment, proposed by Mr. Morse, and seconded by Mr. James, was carried: "That the report be not adopted, but that the Board are prepared to discuss the matter with Messrs. Crompton on the basis of the capital being found by the Board, that being left open for consideration when all the details are before the Board."

Electric Lighting in Coventry.—The Electric Light Committee have presented the following report to the Coventry City Council: "Your committee have invited tenders for the erection of the buildings of the electric light station in Sandy Lane, in accordance with plans and specifications prepared by Messrs. George and Isaac Steane, architects, and have received the following tenders, namely:—

		Extra for brick dado in engine house if required.		Total.	
	£	£	s.	£	s.
Foster & Dicksee, Rugby ...	8,880	210	0	9,090	0
Charles Garlick, Coventry ...	7,700	160	0	7,860	0
John Bowen, Birmingham ...	7,597	145	0	7,742	0
Liggins & Strong, Coventry	7,347	187	12	7,534	12
T. & H. Herbert, Leicester	7,210	172	0	7,382	0
G. F. Smith & Son, Leamington	6,950	188	0	7,138	0
C. G. Hill, Coventry	6,649	180	0	6,829	0

And your committee recommend that the tender of Mr. C. G. Hill be accepted for the work, subject to his entering into a contract satisfactory to the Town Clerk."

Electrical Affairs at Blackpool.—The Town Council a few days ago adopted the following minutes of the Electric Lighting and Tramway Committee:—"Mr. M. Holroyd Smith was instructed to refuse all tramway boxes not supplied in strict accordance with his orders and drawings. Mr. Thomas Parker was asked to accept a sum of £10 10s. in respect of his inspection and report upon the Corporation tramways in December last. Tenders are to be procured for the rails and other ironwork required for the proposed tramways in Lytham Road, and the Town Clerk was authorised on behalf of the Corporation to give all necessary notices to companies or persons in connection with the laying of the proposed tramways in Lytham Road. Mr. M. Holroyd Smith was also authorised to obtain designs and estimates from various makers for the motors and gearing required for the two new large tramway bogie cars now being built by the Lancaster Waggon Company."

Railway Train Lighting.—The Bristol Electric Safety Lamp Works have just executed an order received from the Agent-General for the Cape of Good Hope, for 40 sets of self-contained electric accumulator lamps, arranged for hanging on to the panel of the compartments in the train, and for corresponding fittings for 120 compartments. The lamps weigh about 12 lbs. each, and consist of a flat accumulator, in polished wooden cases, with the light fixed in front at an angle of 45 degrees with the horizontal. The lamps can be fixed at a moments' notice in any of the 120 compartments. The lamps will burn for 15 hours continuously, and the light is about 4 C.P. in front of the reflector. This order is the result of trials made with the company's lamps which have extended over two years.

Gilbert & Co.—This firm have lately secured contracts for both wiring the offices, showrooms, and warehouses of both Messrs. Lazarus & Rosenfeld, Bevis Marks, and Messrs. Geen Evison Stutchbury & Co., Bevis Marks, also the printing factory and offices of Messrs. Marchant, Singer & Co., St. Mary Axe.

Hampstead Electric Lighting.—The Vestry have decided to appoint an electrical engineer to take charge of their electric lighting station at a salary of £200 per annum. The Electric Lighting Committee recommended to the Vestry that electric mains for private lighting be laid down in Eton Avenue and Strathray Gardens at an estimated cost of £1,600. Mr. Thwaites moved the adoption of the recommendation, and said that, by some mistake, Strathray Gardens had been placed there instead of Lyndhurst Gardens. Only one application had been received from Strathray Gardens, but applications for 1,060 lamps had been received from the two other roads. Permission was given for Lyndhurst Gardens to be substituted in the recommendation for Strathray Gardens. This was agreed to.

Moss Side (Manchester) Electric Lighting.—Mr. Marr, of the Collier-Marr Electric Lighting Company, submitted a proposal to the Local Board last Monday for the electric lighting of some of the leading thoroughfares of the district. He said that in place of 156 of the gas lamps now in use, the company proposed to fix electric lights of 36 candle-power in 49 of them, and lights of 16 candle-power in 56 others. In addition it was suggested there should be four arc lights at four points of the district. This would give a total illuminating power of 10,628 candles, against the present illuminating power of 2,026 candles, and the company would undertake to provide this at a cost of £533 per annum. Mr. Marr was requested to submit his proposal in writing, and this he promised to do.

Electric Light at Glasgow.—The sub-committee appointed to consider the subject have reported that they would not feel warranted in recommending that the proposed scheme for the electric lighting of additional streets should be gone into, the cost showing such an increase on the present lighting. They recommend, however, by way of experiment, that 12 incandescent gas lamps should be erected in St. Vincent Street between Buchanan Street and Renfield Street. The question therefore of the further lighting of the streets by electricity may be said to be settled.

Richmond Electric Lighting.—The Town Council last week unanimously resolved "That the Richmond (Surrey) Electric Light and Power Company, Limited, being desirous of extending their mains along the Terrace to a point near the Queen's Hotel on Richmond Hill, this Council directs that the part of the area included in schedule B of the Richmond (Surrey) Electric Lighting Order, 1883, from the corner of Friar's Stile Road to the corner of Queen's Road, opposite the Star and Garter Hotel, shall be added to the area of supply included in schedule A of the said Order."

Business Announcement.—Mr. Herbert Thomas Sully, A.I.E.E., informs us that he has opened offices at 1, Queen Anne Buildings, Baldwin Street, Bristol, as an electrical and consulting engineer, and has arranged with Messrs. Crompton & Co., Limited, of London, and of Chelmsford (with whom he has been connected for the past seven years), to represent them as agent for their dynamo machinery, arc lamps, &c., in the city of Bristol and for the county of Somerset.

Electric Miners' Lamps.—We hear that the lamps (miners') of the Bristol Electric Safety Lamp Works, have been used with great success by the rescuing parties, after the great mining disaster in Karwin in Austria, and it is expected that these lamps will now be generally introduced, as trials made by one of the most important mining companies, and extending over one year, have proved that the lamps are sufficiently strong and durable, and inexpensive in the long run.

Bedford and Electric Lighting.—The Town Council have resolved to make application to the Local Government Board for their sanction to the borrowing of the sum of £12,000 for the purpose of providing the necessary buildings, machinery, and plant for supplying electrical energy within the borough, for all public and private purposes, as defined by the Electric Lighting Acts, in accordance with the plans and estimates prepared by Mr. F. H. Medhurst, B.Sc., M.I.E.E.

Electric Light at Wolverhampton.—The Lighting Committee have been authorised to advertise for tenders for the execution of the necessary works, and provision of all fittings for the supply of electricity, to the following municipal buildings, viz.: Town Hall, Market Hall, Art Gallery, and Free Library, and submit same to the Town Council for acceptance in due course.

Electric Lighting in St. Saviour's, Southwark.—On Wednesday afternoon, at St. Saviour's Board of Works, a letter was received from the Board of Trade, enclosing copy of a letter they had sent to the London Electric Supply Corporation, Limited, in reference to their Electric Lighting Order. The Board of Trade gives its approval to the supply of electrical energy subject to various conditions.

Drake & Gorham.—Among other contracts just placed with this firm in Manchester—where a permanent branch was opened some time back—is the lighting of the Consolidated Bank where they are putting in about 80 lights, the current being obtained from the outside supply. They are also carrying out the re-wiring and entire re-construction of the installation at Holm Acre for Mr. Chas. Behrens of about 80 lights of 16 C.P.

Edinburgh Electric Lighting.—Arrangements have been made for laying the foundation stone of the electric light station on Monday, 25th inst., at 4 o'clock. The Lord Provost, Sir J. A. Russell, will perform the ceremony. There will be a dinner in the Council Chambers afterwards, and later a popular lecture in the Albert Hall, at 8 o'clock, by Prof. Kennedy.

Change of Address.—Mr. Albion T. Snell asks us to announce that his private address in future will be South View, Brondesbury Road, N.W., instead of Salusbury Road as formerly.

Cambridge Electric Lighting.—The Cambridge Electric Lighting Company have given notice that after October 8th they will give a continuous supply at all hours of the day and night.

Hackney and Electric Lighting.—The Vestry have appointed a committee to consider their position in relation to the provisional order secured last year.

Electric Light at Glengarnock.—An installation of a 12-unit dynamo and 16 arc lamps has lately been completed at Glengarnock Iron Works.

Colliery Electric Lighting.—Recently the electric light was introduced into Lumpsey Mines, Brotton, with favourable results.

Price Lists.—MM. P. J. R. Dujardin & Cie, of Paris, have sent us a copy of their latest price list of electric accumulators.

Church Lighting.—Electric light is being substituted for gas at the Marylebone Presbyterian Church, Upper George Street.

CITY NOTES.

The Medical Battery Company.

The creditors, shareholders, and debenture holders of this company were called together last Friday at the Inns of Court Hotel, to consider a scheme of arrangement whereby the business can be carried on in the future.

Mr. Warley (Assistant-Receiver) presided, and having explained the business of the meeting, called upon Mr. Jerome, who acted for the debenture and shareholders, to give details of the scheme.

Mr. Jerome then read out the particulars, from which it appeared that a new company is to be formed under the style of the Medical Electrical Institute, Limited, or such other name as may be selected. The capital is to be £75,000, and to consist of 25,000 £1 preference shares and 20,000 ordinary shares of £2 10s., with power to increase or reduce this number. The preference shares are to bear interest at the rate of 7 per cent., and are to be issued to the creditors of the Medical Battery Company in payment of their claims. The new company is to take over all assets, including the leases of the premises, stock, plant, &c., together with such sum of money as may be in the hands of the receiver for the debenture holders, after deducting certain costs and expenses. Six directors are to be appointed—two to be chosen by the second mortgage debenture holders, two by the creditors, and two by the shareholders. First mortgage debentures to the amount of £3,000 are to be issued for raising working capital, and are to be charged on the company's assets, the rate of interest being fixed at 10 per cent. Then the debenture holders of the Medical Battery Company will accept, in lieu of their present bonds, second mortgage debentures in the new company for the same amount, such debentures bearing 10 per cent. interest. The creditors are to be offered, within 28 days of the scheme being approved, preference shares in the new company to the full amount of their debts, and in the event of another winding up they are to have the first charge upon the assets. Finally, the old shareholders are to receive £2 10s. shares for every £5 share held by them in the old company. In commenting upon the proposal, Mr. Jerome said it had been prepared by the debenture holders with a sincere wish to benefit the creditors of the company. The business had been carried on recently, and had only just paid expenses. But then it had only been kept open for the purposes of realisation, and in order to complete the existing contracts. No attempt had been made to carry on the business in the ordinary sense of the term, and the wares had not been advertised in any way. If the scheme were approved the business could be resuscitated, and carried on in a manner that would defy further attacks.

A short discussion took place at the creditors' meeting regarding the debentures, in the course of which Mr. Harness asserted that, with the exception of a small amount issued in satisfaction of a bill of costs, the entire debentures, amounting to £28,000, were given in exchange for hard cash at the rate of 20s. in the £.

Mr. Jerome corroborated that statement, adding that the whole of the money so raised went into the company's coffers and was used in the business.

A Creditor wished to move a vote of confidence in, and sympathy with, Mr. Harness, but was ruled out of order, and no resolution was put.

At each meeting resolutions were passed unanimously accepting the scheme of arrangement.

Sheffield Electric Light Company.

The third ordinary general meeting of the Sheffield Electric Light and Power Company, Limited, was held on 13th inst. in the Cutlers' Hall. Alderman G. Franklin presided.

The Chairman, in moving the adoption of the report and balance-sheet, said the year ending December, 1893, was notoriously the most unfavourable for electric lighting companies. The almost perpetual sunshine which they had during that year, together with the absence of fogs, rendered it a particularly unfavourable year for such undertakings. Notwithstanding this the increase had continued in the revenue derived from the sale of current. In 1892 the accounts of the company were made up for only nine months, but equalising the periods for the purpose of comparison, it would be found that the income from the sale of current during 1893 had been £3,555 11s., an increase at the rate of £750 a year over 1892. On the other side of the account the cost of generation of electricity had increased by £180 a year, but that increase was due, and more than accounted for, by the extra cost of fuel during the disastrous coal strike of last year. The capital expenditure last year amounted to £19,689 4s. 1d., almost entirely accounted for by the construction of the electric lighting station and also the underground mains, which were laid throughout the whole of the centre of the town. The company were at present liable to be called upon to supply 13,200 8-candle-power lamps, and had machinery at the station enabling them to supply 15,000. They were at present engaged in an important extension to the residential districts of the city. It had long been felt that the demand in the centre of the town was only for two or three hours a day, and as the machinery had to be kept going during the whole 24 hours, it was thought, by means of this extension, they might somewhat equalise the load. When the lights were turned off in the town the consumption would thus be going merrily on in the residential districts of Broomhill and Ranmoor. The new capital had been well subscribed. The application of the company for new shares and debentures was subscribed much better than some of the members of the board expected, and the directors would now be able to go forward, and give the enterprise a fair chance of becoming a good business, and securing for the company the position of being a prominent dividend-paying concern. He said that since the last ordinary general meeting of the shareholders, held in July, 1893, important changes had taken place in the condition and arrangements of the company. All the overhead cables had been taken down, and trenches had been dug in 3¼ lineal miles of streets in the centre of the city. Thirteen miles of metal pipes had been laid in these trenches, and 13 miles of heavy electric mains had been drawn into the pipes. The electric energy, which during the existence of the overhead mains was transformed on the premises of each consumer from a pressure of 2,000 volts to a pressure of 100 volts, was now concentrated and transformed in 10 suitable pits or chambers sunk in the streets. The lamps fixed on consumers' premises were equal to 11,000 30-watt lamps, whilst the capacity for production of the machinery in the station equalled 12,500 similar lamps. Large and important consumers were being wired for electric light supply, and indeed, so steadily was electrical illumination progressing, that the directors had already under consideration the laying down of further pressure machines in the station. Since the directors last met the shareholders, the new station had been successfully opened. The work of laying electric mains to Ranmoor and Broomhill had already been commenced. It was hoped that the current would be available for use in the West End during the autumn. They would see that the balance of profit for the past year was equal to a dividend of 2½ per cent. on the capital then in the concern, but the directors, having regard to the peculiar position in which the company was placed—the fact that a number of new shareholders had done them the honour of taking shares—thought it inadvisable to declare any dividend for last year, but to carry the balance forward to strengthen the current year's revenue.

Ald. Gamble seconded the adoption of the report, which was adopted.

The remuneration of the directors was fixed at £405 per annum. The retiring directors, Ald. Franklin and Ald. Gamble, were re-elected.

The Edison & Swan United Electric Light Company.—An extraordinary general meeting of the Edison & Swan United Electric Light Company, Limited, will be held at the Cannon Street Hotel, E.C., on Tuesday, July 3rd, 1894, at 12·15 in the afternoon, to consider, and if approved, to pass the following resolution, viz.:—"That the provisional agreement dated June 5th, 1894, submitted to this meeting and expressed to be made between the Swan United Electric Light Company, Limited, and this company, for a sale of the Swan Company's undertaking to this company for debenture stock of this company, be, and the same is hereby, approved."

The Anglo-Portuguese Telephone Company, Limited.—This company notifies that coupons No. 13 of the first mortgage and No. 8 of the second mortgage debentures will be paid, less income-tax, by Parr's Banking Company and the Alliance Bank, Limited, on and after the 2nd prox.

The West Coast of America Telegraph Company.—The coupons due June 30th on the debentures of this company will be paid by Messrs Barclay & Co., Lombard Street. Coupons should be left two clear days for examination.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending June 17th, 1894, amounted to £831; week ending June 18th, 1893, £782; increase, £49; total receipts for half-year, 1894, £21,754 corresponding period, 1893, £21,035; increase, £719.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 15th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brasilian Telegraph Company Limited, were £2,379.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, June 13th.	Closing Quotation, June 20th.	Business done during week ended June 20th, 1894. Highest.	Lowest.
184,500*l*	African Direct Teleg., Ltd., 4 % Deb.	100	...	...	...	102 —105	102 —105	...	...
1,134,640*l*	Anglo-American Teleg., Ltd.	Stock	£2 12s.	£2 15s.	£2 11s.	43 — 45	40 — 42	...	...
2,932,680*l*	Do. do. 6 % Pref.	Stock	£5 5s	£5 10s.	£5 2s.	82½ — 83½	76 — 77	81¾	77
2,932,680*l*	Do. do. Defd.	Stock	...	...	...	7⅞ — 8	7 — 7⅛	7 3/16	...
130,000	Brazilian Submarine Teleg., Ltd.	10	8 % §	6¼ % §	6½ % §	12 — 12½	12¼ — 12⅝	12⅝	12½
18,700*l*	Do. do. 5 % Bonds	100	...	...	...	101 —104	101 —104	...	...
75,000*l*	Do. do. 5 %, repayable June 1906	100	...	...	...	109 —113	109 —113	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	... §	10%‖ §	... §	1½ — 2½	1½ — 2½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	140 —145	139 —143 xd	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	3⅛ % §	2 % §	2 % §	1/16 — 3/16	1/16 — 3/16 xd	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12 — 13	12 — 13	12¾	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18 — 19	18½ — 19½	...	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4½%	4 %	4 %	4 — 4½	4 — 4½	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	10 %	9 — 9½	9 — 9½	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½% §	3½% §	...	9¼ — 10¼	9¼ — 9¾	...	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	...	15 — 15½	15 — 15½	15½	15
70,000	Do. 6 % Pref.	10	6 % §	6 % §	...	15¾ — 16¼	15¾ — 16¼	16 1/16	16
105,900*l*	Do. 5 % Debs., repay. August, 1899	100	...	...	...	107 —110	107 —110	...	...
1,294,100*l*	Do. 4 % Mort. Deb.	Stock	...	...	...	113 —116	113 —116	114	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	15⅞ — 15⅞	15⅞ — 15⅞	15⅞	15⅝
62,700*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	...	...	...	105 —108	105 —108	...	...
222,800*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	...	...	...	105 —108	105 —108	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	...	...	...	114 —118	114 —118	...	...
95,100*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	...	...	...	105 —108	105 —108	...	...
129,100*l*	Do. do. do. to bearer, 2,344 to 5,500	...	...	...	...	105 —108	105 —108	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	...	...	...	105 —108	105 —108	106¼	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	...	...	...	107 —110%	107 —110%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	5¼% §	4¾% §	4⅝% §	9 — 9¼	8⅞ — 8⅞	9 3/16	8⅝
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 % §	15⅜ — 15⅝	15⅛ — 15⅜	15⅜	15 1/16
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	8⅜%	21 — 21½	21 — 21½	21⅜	...
200,000*l*	Do. do. do. 5 % Debs.	100	...	...	...	105 —108	105 —108	106	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	43 — 45	43 — 45	...	...
37,548	London Platino-Brazilian Teleg., Ltd.	10	...	...	...	5 — 7	5 — 7	...	...
100,000*l*	Do. do. 6 % Debs.	100	...	...	...	107 —110	107 —110	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	⅜ — 1⅛	½ — 1½	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	...	...	...	1 — 2	1 — 2	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	6 % §	5 % §	...	4⅞ — 5⅛	5 — 5⅛	5 1/16	5
15,000	Do. 6 % Cum. 1st Pref.	10	...	...	...	15 — 16	15 — 16	15⅛	...
15,000	Do. 6 % Cum. 2nd Pref.	10	...	...	...	14½ — 15½	14½ — 15½	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	...	...	...	5⅛ — 5⅜	5⅛ — 5⅜	5⅜	5 11/16
925,017*l*	Do. 4½ % Deb. Stock Prov. Certs. ...	...	...	...	...	115 —117	112 —115	114¾	113
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... ...	... ...	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	...	⅛ — ⅜	⅛ — ⅜	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	...	...	...	103 —106	103 —106	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	5 — 6	5 — 6	...	...
3,381	Submarine Cables Trust	Cert	...	...	...	112 —117	110 —115	112	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1½ — 2	1½ — 2	...	...
146,370*l*	Do. do. 5 % Debs.	Stock	...	...	...	90 —100	90 —100	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	..	...	3 — 5	3 — 5	...	...
249,900*l*	Do. do. do. 5 % Debs.	100	...	...	...	102 —105	102 —105	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	2½ — 3	2½ — 3	...	...
150,000*l*	Do. do. do. 8 % Debs., repay. 1902	100	...	...	...	100 —105	100 —105	...	...
64,242	Western and Brazilian Teleg., Ltd.	15	4 %	2½%	5 %	6¾ — 7¼	6¾ — 7¼	6¾	...
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	...	...	...	6 — 6½	6 — 6½	...	...
33,129	Do. do. do. 5 % Def.	7½	3 %	...	...	2 — 2½	2 — 2½	...	...
178,200*l*	Do. do. do. 6 % Debs. "A," 1910 ...	100	...	...	...	1 7 —110	107 —110	...	...
222,700*l*	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	...	...	...	107 —110	107 —110	...	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	⅜%	1⅛ — 1⅜	1⅛ — 1⅜	1⅛	...
34,563	Do. do. do. 6 % 1st Pref. ...	10	...	...	...	10¼ — 10¾	10 — 10⅛	10¼	10⅛
4,669	Do. do. do. 6 % 2nd Pref. ...	10	...	...	..	9 — 10	9 — 10	...	...
80,000*l*	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	...	...	...	109 —112	109 —112	...	...
$1,214,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	...	...	...	110 —115	110 —115	...	...
169,000*l*	Do. do. 6 % Ster. Bonds.	100	...	...	...	100 —104	100 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

20,510	Charing Cross and Strand Electy. Supply, 1 to 6, 215 to 718, and 10,001 to 30,000	5	...	5 %	4½%	4½ — 5½	4½ — 5½	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,000—180,000	10	...	...	...	12 — 13	12 — 13	12⅝	...
20,000	Do. do. 6 % Cum. Pref., 1 to 20,000	10	...	6 %	6 %	13½ — 14	13½ — 14	14	13⅞
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) £75 paid	...	...	...	...	84 — 86	87 — 90	90	85¾
19,900	*Electy. Supply Co. of Spain, 101 to 20,000...	5	...	...	...	... ...	... ...	...	...
45,000	†Liverpool Electric Supply, £4 10s. paid	5	4½%	5 %	5 %	6⅜ — 6½	6⅜ — 6½	...	...
49,900	*Metropolitan Electric Supply, Ltd., 6,101 to 50,000 ...	10	1 %	2 %	2½%	8¼ — 8⅝	8½ — 9	8 13/16	8⅝
100,000*l*	Do. 5% Deb., 1 to 10,000 in bonds of £10, £20, £40	...	...	...	...	107 — 110	107 —110	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	...	4½ — 5½	4½ — 5½	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	8½%	7½%	4½%	7 — 7½	7 — 7½	7⅜	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8¼ — 8⅜	8¼ — 8⅜	8⅜	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	...	3½%	4 %	6¼ — 6⅜	6¼ — 6⅜	6⅜	6 1/16

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, June 18th.	Closing Quotation, June 20th.	Business done during week ended June 20th, 1894. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	...	6 % §	6 % §	2¾— 3	2¾— 3	2⅞	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	6 % §	6 % §	2⅛— 2⅜	2⅛— 2⅜	2⅛	2 3/16
125,000/	Do. do. 4½ % Deb.	Stock	...	...	...	108 —111	109 —112	110	...
630,000/	City and South London Railway	Stock	...	⅛%	⅛%	36 — 38	36 — 38	37	36½
20,000	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 20,000	5	7 % §	7 % §	7 % §	3 — 3½	2¾— 3¼	...	...
50,000/	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	...	...	...	95 —100	95 —100	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	...	...	...	¼— ⅜	¼— ⅜	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	...	...	...	1½— 1¾	1½— 1¾	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd , 1 to 66,750 ...	2	*nil*	*nil*	*nil*	¼— ⅜	¼— ⅜	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil* ¶	*nil*	*nil*	1⅛— 1⅜	1⅛— 1⅜	1 1/16	...
67,385	Elmore's Wire Mfg., Ltd., 1 to 67,385, issued at 1 pm. ...	2	*nil*	*nil*	*nil*	⅞— 1⅛	⅞— 1⅛	1	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	*nil* §	½— 1½	½— 1½	...	...
9,600/	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	...	...	6½— 7½	6½— 7½	...	...
6,837	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	5 %	6½— 7½	6½— 7½	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	12½%	23 — 24	23½— 24½	24	23½
200,000	Do. do. do. 4½ % Deb., 1896	100	...	...	...	103 —105	103 —105	104¾	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	...	1 %	8½— 8⅝	8 7/16— 8 9/16	8¼	...
6,295	† Do. do. Pref., £8 paid	10	...	...	...	12¾— 13½	12⅝— 13½	...	...
78,949	Swan United Electric Light, Ltd., £3½ paid	5	11 % §	10 % §	7½% §	2 — 2½	2 — 2½	2⅜	2
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	20 %	39 — 41	39 — 41	41	39⅞
150,000/	Do. do. do. 5 % Bonds, red. 1894	100	...	...	...	104—107	104 —107	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
CROMPTON & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%§; 1891—7%§; 1890—8%§.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5¼—5⅜.
Electric Construction Corporation, 6 % Debentures, 87—92.
Electric and General Investment, shares of £5 (£1 paid), 1¾—2¼.
Electricity Supply Corporation, Ordinary of £5, 5—5¼.
House-to-House Company (£5 paid), 1—1½.
Do. do. 7 % Preference, of £5, 5½—5½.
Do. do. 6 % Debentures of £100, 101—103.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 4¾—5¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6¼—6⅜.
Liverpool Electric Supply, £5 (fully paid), 6½—6⅝.
Do. do. £3 10s. paid, 4½—4⅝.
London Electric Supply Corporation, £5 Ordinary, ⅞—1⅛.
Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 101—103.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid), 4¼—4⅜.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

SOME REMARKS ON POWER DISTRIBUTION BY ELECTRICITY, WATER, AND GAS.*

BY MR. ED. C. DE SEGUNDO.

(*Concluded from page* 712.)

Of course, the engine and boiler as heat machines are not to be held accountable for the whole of this loss. It is mainly due to the conditions of working. But the question that naturally suggests itself under these circumstances is, is there no other and more efficient manner of generating and distributing light and power on an intermitting demand than by steam-power, generating electrical energy and distributing it by means of copper mains?

It must not be forgotten that the coal consumption is by no means the only factor to be considered. Rents, rates and taxes, maintenances and distribution expenses, depreciation, management expenses, and a host of other items have to be tacked on to the cost of coal consumed before the figure is reached from which profits can be calculated.

But even on this basis the total for power delivered is strikingly smaller in the case of hydraulic power supply than in that of electric supply.

In a recent paper read before the Institution of Civil Engineers by Mr. E. B. Ellington, it was stated that the total cost per 1,000 gallons delivered at 700 lbs. per square inch, was 12s. 6d. Now 1,000 gallons at 700 lbs. per square inch is equivalent to 8·34 horse-power hours, or 6·25 kilowatt hours nearly. There is no electric supply company in London who deliver 1 kilowatt hour at a less total cost than from 3·5 to 4½d. to themselves. Thus the cost per equivalent of 1 kilowatt hour is rather more than double in the case of electric supply than in the case of hydraulic supply. The question is, as to whether this economy can be ascribed wholly to the superior economy of the steam engine in all hydraulic power stations, having regard to the fact that not only is the hydraulic load curve similar in form to the electric load curve, but the load factors in both cases are similar. The author thinks not entirely, as a certain proportion of this economy must be due to the difference in the inevitable losses in the system of distribution, and also to the difference in capital outlay for large powers.

In comparing distribution of power by high pressure water and by electricity, due consideration must be had to the purposes to which power is to be put. For working lifts, or cranes, or presses, it is doubtful whether any simpler and better means could be provided in a city like London than water pressure.

If, on the other hand, the form in which the power is delivered has to be changed before it can be applied, it is quite possible that the efficiency of transformation may be so low as to dissipate the economy attained in generation and distribution. Compare, for instance, the number of transformations necessary to enable a lift to be worked, and an incandescent lamp to be lighted from a central power house.

LIFT.

Efficiency.	Hydraulic power.	Efficiency.	Electric power.
per cent.		per cent.	
70	Boilers.	70	Boilers.
13	Compound condensing engines.	9	Non-condensing engines
80	Pumps (including mechanical efficiency of engine).	80	Dynamos (including mechanical efficiency of engine).
99	Distributing system.	88	Distributing system.
		80	Motor.

Of the 14,500 thermal units liberated by 1 lb. of coal, 1,044 thermal units would reappear as useful work on the hydraulic system, and 478·5 thermal units on the electric system.

ELECTRIC LIGHTING.

Efficiency.	Hydraulic power.	Efficiency.	Electric power.
per cent.		per cent.	
70	Boilers.	70	Boilers.
13	Compound condensing engines.	9	Non-condensing engines.
80	Pumps.	80	Dynamos.
99	Distributing system.	82	Distributing system.
66	Motor.		
90	Dynamos.		

* Read before the Society of Engineers on Monday, June 4th, 1894.

On the hydraulic system about 620 thermal units should reappear in useful work, and on the electric system about 600 thermal units.

The foregoing assumptions are not made with regard to any particular load factor, but as the load factor is found to be very similar in public electric supply stations and public hydraulic supply stations, the conclusions indicated by the figures should not be materially altered.

There is, of course, nothing very new about this result, but it is sufficiently striking to have induced a Belgian engineer, of considerable reputation, to devote a large amount of time to the development of a system of hydraulic distribution in generating electrical energy which should enable electrical energy to be sold at considerably cheaper rates than at present.

It is unnecessary to discuss M. Van Rysselbergh's scheme in detail. It is evident that the only directions in which the efficiency of a system as a whole can be increased are (1) by decreasing the number of transformations of energy, and (2) by increasing the efficiency of either or all of these.

Now the number of transformations of energy is not decreased but increased in the hydraulic system. The efficiency of boilers and dynamos cannot be very different in both systems. The difference in the cost of the distributing system is conditioned by circumstances; there remain, then, two efficiencies to be improved on, the efficiency of the engine and the efficiency of the distributing system.

The economy effected by a triple expansion condensing engine working as it does in an hydraulic power station at full load per stroke over the steam engines forming part of the "steam dynamos," now much used in electric generating stations, might well reach 50 per cent.; that is to say, where the steam engine of the steam dynamo gives 10 per cent., the triple compound as above might yield 15 per cent. The loss in a mile of hydraulic main, say 6·5 inches diameter, when transmitting 100 horse-power at 700 lbs. per square inch at a velocity not exceeding 3 feet per second, would not greatly exceed 1 per cent., whereas the average loss in an electric distributing system rarely is less than 12 per cent., though doubtless this could be improved upon.

Against these sources of economy must be placed the loss in the water motor, the loss in the extra transformation of motive power into electric light, and the loss in the low-tension network surrounding each distributing station. Further, hydraulic mains have to be placed at a considerably lower level than the electric conduits need be for many reasons, and it can scarcely be even a matter of doubt that the total commercial efficiency of the whole hydro-electric system, by which is meant the useful efficiency modified by all such considerations as rents, rates, and taxes, maintenance and depreciation, &c., will compare unfavourably with the total commercial efficiency of direct electric supply.

There can be no doubt, however, that power can be produced and delivered hydraulically at a smaller cost than the electrical equivalent electrically. There must be a reason for this, and the reason is not far to seek. In the hydraulic power station a more efficient engine can generally be used; then this engine can be worked more efficiently owing to the fact that although the engine may vary in speed, it works always at full load to the stroke. There can be, further, a much greater efficiency in distribution through pipes. In hydraulic power supply the pressure is not a function of the speed of the pump (as in direct electric supply it is a function of the speed of the armature) but the pressure in the mains is maintained outside of the engine and pump, which only deliver enough water at a constant pressure to supply the demand on the mains.

At first sight it seems easy to apply this principle to electric supply by the introduction of an electric accumulator or storage battery to keep up the pressure on the mains. But, unfortunately, the analogy between an hydraulic and an electric accumulator is not quite complete, it breaks down in one important detail, namely, that while the hydraulic accumulator reacts in the same way upon both main and pump, the electric accumulator only acts in an analogous manner towards the main. Its effect upon the dynamo or electric pump is to drive the pump unless the pump is driven sufficiently quickly. What is wanted to complete the analogy is the analogue of the non-return valve, and this so far has not been discovered. Moreover, while pressure can be exerted by a pump, whose plunger is stationary, the pressure exerted by the electrical pump or dynamo is a function of the speed of rotation of the armature. Thus, in order to supply a small demand, the steam engine of an electric generating station has to work at about 90 per cent. of the speed required to supply the full demand.

There is no reason why an electrical generating station should not be able, provided the demand is sufficiently large and varied, to so apportion its generating units as to keep each unit in work loaded to 90 per cent. of its full load, in which case the only losses in the station would be 10 per cent. stand-by in boilers, radiation, &c. In the Berlin central station, where, owing to continental habits of life, the demand is more favourably distributed over the 24 hours, such a condition is very nearly approached.

Now let us briefly consider how power produced by gas engines can meet the needs for electric light for a large town provided with a complete network of gas mains.

In this case (which is practically the case of every large town in the civilised world) the electric light comes as competitor against the method of illumination which has practically only just established a firm reputation for reliability, economy, efficiency, &c. There is no doubt that the conveniences of gas for lighting and heating are apt to be overlooked because of our familiarity with them. Had we experienced the inconveniencies of oil and candle lighting, I feel sure the electric light would not have made so much progress as it has done. Further, the gas business is in the hands of a powerful body, powerful alike in experience and in resource.

Experience of practical working in London and other large towns shows that in certain districts, and under certain conditions, there is a sufficient demand for the electric light to make it worth while to work independently of the gas company altogether. But consider the very vast majority of country towns already supplied with gas, where it is obvious that an independent electric light company would eke out a very miserable existence, and that probably for only a short time; it would certainly seem reasonable that a combination of electric light and gas interests would solve the problem of electric supply to the inhabitants, and if this is so, then the principle ought to apply *a fortiori* to large towns.

At present these interests conflict, and it is universally experienced that someone has to pay for this conflict.

Let us try and examine this a little more closely. If electric light and gas interests harmonise, the first advantage that suggests itself is the ready made central station, namely, the gas works. It is then necessary to establish distributing stations at suitable points in the town. Each distributing station would consist of gas engines and dynamos, and regulating apparatus. Each distributing station would supply its own network of mains for the needs of its own neighbourhood. These networks would have to be connected by a trunk main, so that any one station could be relieved by any other in case of emergency, and during the period of light load. The details of the plant of each station, and the number of stations, would be dictated by local conditions, so that it is impossible to do more than state the broad principles.

As there would be no boilers, no chimney stack would be required. Probably, in nine cases out of ten, the basement of some house could be adapted to accommodate the necessary plant, hence a great saving would be effected in special buildings. Further, the labour required would be diminished. The cost of superintendence would probably remain the same, but might be increased.

Now as to the cost per unit delivered. There is fortunately not much difficulty in determining this, as many examples of the generation of electrical energy by gas power now exist. The author has selected the results of the weekly records of a plant at Bradford, supplying 300 lamps. The total cost per kilowatt hour delivered is almost exactly 2d., with town gas at 3s. 3d. per 1,000. But to adapt this to a distributing station, 5 per cent. should be added for loss in mains, and 0·3 pence per kilowatt hour for depreciation in plant and buildings. This would bring the cost to 2·4 pence. Adding the very liberal allowance of 0·6d. per kilowatt hour for management expenses, the total cost would amount to 3d. per kilowatt hour delivered.

This is a lower figure than that usually realised in practice by any purely electric supply company working under the conditions above assumed, and no doubt this aspect of public electric supply has for some reason or other not received the attention it deserves.

In order that the two systems (direct use of gas and gaso-electric) be commercially equivalent, the cost of maintenance of the plant, the interest and depreciation and management expenses must be compensated for by the economy in gas consumed.

Now it is frequently thought that nothing can be more economical than the system of sending the gas direct to the burner. But this is far from being true. The miserably low efficiency of the gas burners is rarely appreciated. According to Prof. Tyndall, the efficiency of the gas burner is 0·317 per cent. Taking the calorific value of London gas at 620 thermal units per cubic foot, only the equivalent of 10 thermal units reappear as light out of a possible 3,100 thermal units in a 5-foot burner. When gas is utilised to produce motive power, its efficiency, and that of the incandescent lamp is so superior, that a very different result is obtained. The efficiency of a 16 per cent. incandescent lamp being about 6 per cent., and assuming a mechanical efficiency of 80 per cent. for the gas engines, and 85 per cent. for the dynamos, including loss in transmission, it is found that about 25 thermal units would reappear as light out of a possible 3,100. So that in spite of the three-fold transformation of energy introduced, the final result is increased 2·5 times. This ratio would, of course, be still further increased in the case of arc lamps. The value of these ratios, taking minimum values in the case of electric generation by gas engine power, are as follows:—

Character of burner.		Percentage increase of candle-power obtainable by using a gas engine to drive a dynamo supplying electric lamps, as compared with that obtained by burning the gas direct.
Gas.	Electricity.	
		Per cent.
A good ordinary 5 feet gas burner, such as a Bengel burner.	An incandescent electric lamp, using 4 watts per candle, and giving 16 per cent.	78
A Wenham lamp.	An arc electric lamp of same power as Wenham gas lamp.	227

The reason of this is, that the chemical combustion of coal gas with oxygen yields a flame in which the undulatory vibrations of a sufficient frequency to become luminous are extremely few compared with the heat waves, whereas in a gas engine it is these heat waves that are transformed into mechanical energy.

The chief points of a gaso-electric system of distribution may be summed up as follows:—

1. The generating station already exists, and may be considered as an eccentric power house.

2. The existing gas mains are available, hence there is no question of a separate main network being laid as in the case of hydro—or æro—electric supply.

3. The useful efficiency of gas is out of all proportion greater when utilised as a motive power than when burnt direct in burners, and this, in spite of the extra transformations of energy introduced.

4. It is more than probable that under a system such as has been discussed above, the cost of maintenance, superintendence and management expenses, will be less than under conditions of independent electric supply.

5. By paving the way for the substitution of electric for gas lighting without conflict of existing interests, an incalculable benefit is conferred on the community.

Of course the hydro-electric system may be treated from the same point of view if once hydraulic supply mains exist. But the present efficiency and character of high pressure water motors do not suggest the possibility of any very great economy being effected. It must not be forgotten that Van Rysselbergh's claim to economy is based upon a motor efficiency of 80 per cent., which, though not unattainable, is very high, and could not be relied on as an average result in practice. But for large private installations, the energy supplied by the hydraulic power company could with advantage be utilised.

In conclusion, the author wishes to express his sense of the necessary incompleteness of the paper as compared with the title, but he hopes that the discussion may bring forward further points of interest he may have overlooked in the limited consideration given to the three branches of the subject which have been referred to, and trusts that the question of harmonious working of gas and electric light interests may also receive its share of consideration in the discussion.

THE ROYAL SOCIETY CONVERSAZIONE.

THE Royal Society held its annual *conversazione* on June 13th at Burlington House; the display of apparatus and specimens took its usual place in the programme. By an examination of the exhibits at this meeting, it is sometimes possible to form an idea of the progress which science has made through the past year. This time, however, from an electrical view-point at any rate, we hope that this method of estimating the advance is not to be trusted, for there appeared to be scarcely anything which could fairly be said to belong to the work of the past 12 months. Indeed, we are bound to confess that many of the electrical exhibits took rather the form of "pot-boilers" than of substantial developments of science.

Hughes's Induction Balance was presented in three various forms. It appeared first as a mooring swivel for lightships, next as a measurer of the amount of obstruction in the *meatus* of the human ear, and lastly, as an alleged "proover" of the ostensibly bullet-proof shields. The swivel, which is due to Mr. J. WIMSHURST, is highly ingenious. It is intended for the purpose of avoiding the kinks in cables attached to moored lightships during the movements consequent upon a storm, or the rise and fall of tides. The method consists in arranging two suitably wound and protected coils upon a central pin of iron, around which, as an axis, they can easily turn. This complete swivel, or shackel, forms the link between the ship's chains and her moorings, one coil being contained in each movable half of the swivel. The iron pin is the magnetic connection between the two coils, which can thus act inductively upon one another in any position. One of these coils is joined up to the shore, and the second is in circuit with a telephone on the ship; the communication is thus established without putting "turns" into the cable.

Mr. T. P. HAWKSLEY calls his instrument for comparing the relative perceptions of hearing, a "sonometer;" this is, perhaps, quite a legitimate use of the word, but scarcely the conventional one. The apparatus has two fixed primary coils, of unequal winding, between which a secondary coil slides. The primary circuit is interrupted by a suitable device, and the secondary coil is connected to a deep-note telephone, from which proceeds a tube for insertion in the ear. At a certain point along the slide-rod, to be determined separately by each ear under test, the sound of the make-and-break is no longer heard. The inventor claims that the distance passed over along the scale before this silence occurs is a measure of the acuteness of hearing.

Prof. SILVANUS P. THOMPSON was responsible for the application of the Hughes principle to the alleged detection of bullets in ostensibly bullet-proof shields. Far more worthy of notice, however, was his admirable demonstration of rotary magnetic fields. This included various models of multiphase motors and conversion transformers, together with a veritable ostrich nest of things to be rotated. The professor also exhibited a three-phase incandescent lamp, constructed by Mr. E. Gimingham.

Dr. LODGE showed a Branly tube of filings used in connection with electric radiations. It was chiefly interesting for its compact arrangement. A small copper cylinder contains a piece of zinc and sponge, forming a battery; it has also within it a coil and suspended needle mirror, and, lastly, the Branly tube or "coherer." These are connected in series. Electric surgings in the air, or in a scrap of wire pegged into the lid, increase the conductance of the circuit, as in the usual experiments.

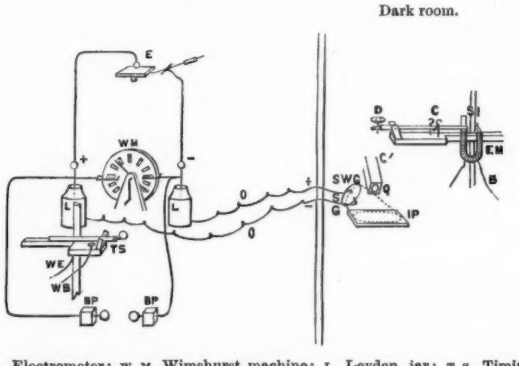
The telautograph of Prof. ELISHA GRAY was exhibited in the archives room throughout the evening, and was thoroughly appreciated by all who saw its wonderful performance. We have previously described this remarkable invention.

Mr. C. T. SNEDEKOR brings his little burnt-offering from New York. His invention is enclosed in an "elastic and flexible" covering of silk or wool, so that it can be "applied to and envelop" any part of the body as a fomentation. It can also be used for a domestic Turkish bath, or as a foot-warmer; and generally for warming purposes in schools, bed-rooms, or carriages. In short, it is a blanket threaded with wires, so that it can be heated by electricity; it is by far the cosiest application of electricity we have ever seen, and we wish it every success.

The POSTMASTER-GENERAL put on view some Wheatstone transmitters and a Hughes type printing telegraph, driven by Willmott's air-motor. This motor makes it possible to dispense with the weights and winding gear of the older system of driving, but it retains externally the same adjusting handles. It replaces also the beautiful mechanism which formerly regulated the speed; but it works itself so perfectly that any regrets in this regard will probably be short-lived.

Mr. J. W. SWAN, F.R.S., shows this year some gold leaf made by electro-deposition. The leaves were prepared by depositing a thin film of gold on a highly polished and extremely thin electro-copper deposit. The copper was then dissolved by perchloride of iron, leaving the gold in an attenuated condition. The leaves are, approximately, four-millionths of an inch thick; they show the transparency of gold very perfectly when viewed by transmitted light.

The use of spark-photographs in obtaining pictures of falling bodies was exhibited by Prof. A. M. WORTHINGTON, F.R.S., and Mr. R. S. COLE, M.A. There is a general resemblance between their method of working and that by which Mr. Boys originally photographed bullets; except that in this case the actual object is observed, and not its shadow. The photographs shown were obtained by allowing a drop to fall in absolute darkness, and illuminating it at any desired stage of its splash by a suitably timed Leyden jar discharge between magnesium terminals. The spark, which occurred very near the place of impact, was produced at the focus of a deep silvered watch glass, subtending an angle of nearly 180°. A single quartz spectacle lens was substituted for the usual camera lens, thus avoiding the absorption of photo-rays by the glass.



E, Electrometer; W M, Wimshurst machine; L, Leyden jar; T S, Timing sphere; B P, Block of paraffin; W E, Wire to electro-magnet; W B, Wire to battery; O, Wire from outer coat of jar; S G, Spark gap; S W G, Silvered watch glass; C', Camera; Q, Quartz lens; I P, Illuminated plate; D, Drop; C, Catapult; S I, Soft iron; E M, Electro-magnet; B, From battery.

ARRANGEMENT OF APPARATUS FOR PHOTOGRAPHING THE SPLASH OF A DROP.

The method consists in letting fall, simultaneously with the drop a metal timing-sphere between two other insulated spheres connected to the inner coats of two large, oppositely charged Leyden jars that stand on the same badly-conducting table. From the outer coats of these jars wires are led into the dark room, and there terminate in a spark gap between the magnesium terminals at the focus of the silvered watch glass. A Wimshurst machine is turned till the lower ball of a rough electrometer is lifted and strikes a glass plate. Then the timing-sphere is liberated by tossing up, by hand, the remote end of the light, horizontal, pivoted rod that has supported it. This action breaks the contact of crossed wires beneath the rod, and consequently the current flows in through the electro-magnet in the dark room; at this moment an India-rubber catapult tosses up one end of a similar horizontal lever, at whose other end the drop has been supported, without adhesion, on a smoked watch glass. By this means sphere and drop are left in mid-air free to fall at the same instant.

The sphere, in its fall, discharges the inner coats of the two Leyden jars, and this produces a simultaneous discharge at the spark gap between the outer coatings. The timing of the spark is effected by adjusting the height of fall of the timing-sphere, by sliding the liberating apparatus up or down the vertical supporting rod.

Prof. C. V. BOYS, F.R.S., had a collection of apparatus and photographs in illustration of his recent determination of the Newtonian constant of gravitation and the earth's mean density. His method, which depended upon the observation of the relative attractions between gold and lead spheres placed at measured distances from one another, was a considerable modification of that used a hundred years ago by Cavendish. The more accurate measurement of the force of attraction between the artificial planet of pure lead and the artificial satellite of pure gold, has been rendered possible by the use of quartz fibres as a means of suspension. Some idea of the care necessary in these measurements can be formed when it is remembered that the actual forces dealt with were equivalent to the weight of a five-millionth of a grain acting on a lever arm an inch long; this is approximately the force with which the gold spheres attracted the lead ones. The accuracy attained was something like 1 in 10,000. The mean density of the earth has now to be taken as 5·5270.

Miss EDNA WALTER, B.Sc., and Mr. H. BECKLY BOURNE exhibited a graphic method for plotting out the angles between the

facets of crystals. It is really a projection goniometer, which is provided with a reference sphere, upon which the angular measurements can be mechanically recorded. The crystal is mounted in such a way that it can be rotated about a horizontal or vertical axis; the sphere, which is placed a little above the crystal, can be similarly rotated; or any pair of axes at right angles to one another may be made the respective axes of rotation. A special gearing between the crystal and the sphere automatically ensures an identical angular motion between them. The crystal being now *in situ*, its faces are successively brought into parallelism with a fixed plane. A marking stylus is provided, which makes a cross upon the sphere for each successive position of the crystal, the stylus always touching the sphere at the same point in space. In this way a projection is made upon the sphere of the normals to the respective faces of the crystal, exactly as though the crystal was at the centre of the sphere, and the normals were bristling out from each facet to the spherical envelope.

A REVIEW OF THE PROGRESS OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.*

By EDWIN J. HOUSTON, Ph.D.

THE American Institute of Electrical Engineers represents the electrical profession in all parts of our great land, and welcomes into its membership bright and progressive men in the electrical profession wherever they may be located. But while the Institute is in no sense a local body, so that no city can properly claim as a right the high privilege of having the annual meeting held in it, yet there is, perhaps, at this time a special fitness that the annual meeting which witnesses the closing of the first decade of our association should be held in the City of Brotherly Love, where the Institute had its birth.

In our nineteenth century activity events move rapidly. In less than a decade from the time of the Centennial Exhibition of 1876, namely, in 1884, the time had come when the advantages of congregation as opposed to segregation were to be demonstrated, when the lonely investigator was to be brought into contact with his brother toiler and taught the advantages of organised work and a free exchange of ideas.

Happily, the International Electrical Exhibition in Philadelphia of 1884, already alluded to, brought together the workers in electricity both in this country, and to a certain extent, in other parts of the world, not only during the exhibition itself, but especially during the completion of the buildings and the arrangement of the exhibits. The varied exhibits thus brought together from all sides were a revelation to these hitherto independent workers, and showed them, from what had already been accomplished by electrical science, what might reasonably be expected in the near future. The stimulus, so excited, culminated in the organisation of the distinguished body I have now the honour of addressing.

At the same time the U.S. Government appointed a United States Electrical Commission, authorising it to conduct a National Conference of Electricians in Philadelphia during the progress of the International Electrical Exhibition. Fortunately for the cause of electrical science, the commission after due deliberation determined to appoint as members of this conference not only those investigators in the physical laboratory and lecture room, the college and university professors whose labours have always proved of such immense value to the world's weal, but also those equally important investigators, the inventor and actual worker in the commercial electrical field, whose knowledge of principles is based on actual experience, a class that proves the correctness of its ideas by subjecting them to the test of actual trial on a commercial scale.

There was thus convened in 1884, in the City of Philadelphia, a notable gathering of men who had long toiled in the electric field, both in the so-called pure sciences and in the applied sciences, and I feel sure that each class recognised the fact that it learned much from the other. In this notable assembly of electrical students our American Institute of Electrical Engineers originated.

Its present rate of increase is fully equal to that of our English cousin, viz., the Institution of Electrical Engineers. Although the London Institution had the start, and has the advantage of us in membership, yet I look forward in the near future to a membership in our body that will be fully on a par with theirs.

I think it would be difficult properly to estimate the good that has accrued to electric science, not only in this country but also in the world at large, from a properly organised association of specialists in a practical branch of science like that of electricity. If we can properly trace, from the circumstances attending a single electrical exhibition and series of conferences held in Philadelphia in 1884, a great awakening in the field of electricity, what must have been the influence for good, exerted by a body like ours, which I think I am correct in saying includes all the distinguished electricians in this country.

In order to inquire what has been the nature of this influence, let us briefly examine the history of the American Institute of Electrical Engineers during the ten years that have elapsed since its foundation, and see whether, in the first decade of its existence, it has duly availed itself of its great opportunities. Let us inquire what great inventions and investigations have been made by its members. I think that as a result of its inquiries, you will agree with me that our Institution has nobly fulfilled the expectations reposed in it, and that electricity is much further advanced than it would have been had the American Institute of Electrical Engineers never been organised.

A glance at the *Transactions* of the Institute will show the extended and valuable character of the work of its members. This work embraces notable inventions, extended commercial applications, and valuable researches, as, for example, researches in high frequency discharges; the development of alternating current apparatus for electric welding, and for the transmission of power; improvements in continuous current apparatus; improvements in the practical applications and control of electric motors for traction, mining, manufacturing and other purposes; improvements in telephony and telegraphy; improvements in the application of electricity to various chemical processes; improvements in designs for electric machinery; improvements in electric lighting apparatus of various descriptions, and developments in electro-therapy.

The work of the Institute as a body has also been of a broad and valuable character. I have already pointed out to you, in my inaugural address of last year, the valuable contribution the Institute made to the Chicago Congress and Exhibition of 1893. Since that time, as you are aware, organised work, under the auspices of the Institute, has been and is being, carried out in different parts of the country, as well as in England, for the completion of some of the work the Chicago Congress was obliged to leave incompleted, viz., the determination of suitable standards of light and of illumination.

Another action of which I think the Institute may be proud, has been its provisional adoption of the well-known names of Gilbert, Oersted, Gauss and Weber, for the most important quantities in the magnetic circuit, thus filling a well defined void in the practical development of the dynamo, motor and magnets generally. These names have already been favourably commented on in Europe, where they have been embodied in at least one standard text-book.

Up to this date there has been much uncertainty as to the meaning which should properly be attached to the very important term "inductance." It was hoped that the Chicago Congress would decide this question, but as this hope was not realised, the Institute, by appealing to the prominent affiliated institutions in Europe, has been enabled to entertain the concensus of opinion upon this matter among electrical engineers all over the world, and has to-day adopted the meaning of "inductance" as a "coefficient of induction," this being the world's majority verdict, so far as it has been possible to obtain it without the aid of an International Congress. It has also adopted the word "reactance" for that quantity in alternating current circuits, whose square added to the square of the resistance is the square of the impedance.

It would be ungenerous in me in thus reviewing the causes which have led to the development of electrical science in this country, to fail to mention another potent factor. I refer to the electrical press. I recognise its power and the good it has accomplished in spreading broadcast over the country, not only to the members of the Institute, but to all interested in electrical progress, the knowledge of every great advance made in electric science. In a certain sense, however, the electrical press supplements the influence of the Institute, because the press, unlike the Institute, cannot bring electrical workers together, but can only guide and disseminate the conclusions they have reached.

The growth of the electrical press has kept pace with the growth of electrical science. In 1876 the power of the press was considerably feeble. The exhibition of 1884 caused, perhaps, as great an increase in the power and influence of the press, as it did in the development of the science of electricity itself, and, great as has been the marked improvement in electrical science, as demonstrated by the Chicago Congress of 1893, I think close observers will agree with me that such progress has been fully equalled by the wonderful improvement in the electrical press of our country.

There is another Association of Electrical Engineers of the same high standing and governed practically by the same principles as that of the American Institute of Electrical Engineers, and this is our affiliated association, the Institution of Electrical Engineers, with its headquarters in London, England. Like our association its membership contains the leading electrical engineers and experts both in the country in which it is located, and in the surrounding countries.

It is, I think, a significant fact, that the countries in which there has been so marked a progress in electrical invention and engineering are those which possess the advantages of combined effort on the part of all its electricians. The reason is, I think, evident; under these circumstances, there exists the enthusiasm which comes from properly organised effort; the rapid progress which is encouraged by friendly rivalry and the incentive to increased and continued effort bred of healthy competition. I think I can safely assert that America, England, France, and Germany, owe much of their marked advance in electrical science to the existence of their organised bodies of electricians, such as is found in the American Institute of Electrical Engineers, the Institution of Electrical Engineers, the Société Internationale des Electriciens, the Elektrotechnische Verein, and the Physikalisch-Technische Reichsanstalt, and I feel sure from the great number of able electricians of Italy, Austria, Switzerland, Belgium, Russia, India, and other parts of the world, that the progress made in these countries, a progress which is confessedly great, would be still greater if they but tried the advantages of electrical work conducted on the co-operative plan.

It may be advantageous here to review some of the advantages of membership in such learned associations, as for example, the Institute in which we are the most interested. Among the many advantages are the following: Concentration of effort; increased mentality excited by generous rivalry; systematic explorations into the domains of the unknown; a tacit agreement as to what shall be regarded as the standard of good work; the practical establishment of a practical

* Abstract of inaugural Presidential address, delivered at the annual meeting of the American Institute of Electrical Engineers, May 15th, 1894.

high court of last resort by whom all disputed technical questions in electrical engineering shall finally be settled; the removal of electric work from the region of guess work to that of certainty, permitting results to be as surely predicted as in other sciences, and consequently the increased stimulus to the successful investment of capital in electrical enterprises; the reduction of misdirected effort by the promulgation of information concerning what has been attempted or achieved in any direction; and, last but not least, the means of establishing a rapid intercommunication of ideas between different parts of the country to others.

As I look over this assembly of distinguished electricians I am particularly impressed with this thought: Our average member, though old in actual experience, is nevertheless seldom hoary in years. There must be something in electricity, though what it is I would not venture to say, which attracts the younger and more vigorous members of our race to its study. Perchance it may be that in this mysterious force there exists some lingering traces of the long sought for "fountain of youth," but, be it what it may, I find in the fact that such comparatively young men have been able to do so much for the world's weal in a special science, a bright promise of what they may be able to accomplish before their tasks are completed.

Such is the record of the past 10 years of our Institute! What will be the history of its next 10 years? I look forward confidently to a still greater and more marked progress than that which has characterised it during the first decade of its existence. I believe that during the next decade its standing will be such that all notable achievements and discoveries in the electrical field in this country will either originate in this body, or be carried out under its direction, and that the American Institute of Electrical Engineers will be the acknowledged centre of the industry and art it now so ably represents.

But while I believe I see so bright a future for our American Institute of Electrical Engineers, I must not be unmindful of the fact I have so earnestly endeavoured to point out, viz., the advantages to be derived from co-operation, and that our Institute is only one of several such organisations in different parts of the world, and that the highest purposes of the science and art in which our interests are so closely centred can only best be realised by the most cordial sympathy and hearty co-operation with all associated societies and their members, wherever they may be.

NEW PATENTS—1894.

10,798. "Improvements in the lighting, and in lamps used in coal mines and the like, by electricity." W. W. McLAUCHLAN. Dated June 4th.

10,803. "Improved means for waterproofing fabrics, paper, and the like, and for insulating electrical conductors." W. THOMSON and A. E. MAYOR. Dated June 4th.

10,823. "A new or improved process for the extraction of aluminium from certain clays by electrolysis." A. F. B. GOMESS. Dated June 4th.

10,851. "Improvements in electric railway signals." H. H. LAKE. (Communicated by F. Beattie, United States.) Dated June 4th. (*Complete.*)

10,853. "Improvements in electrical accumulators or storage batteries." J. Y. JOHNSON. (Communicated by La Société L'Accumulateur Fulmen, France.) Dated June 4th. (*Complete.*)

10,917. "Improvements in electric safety fuses or cut-outs." S. Z. DE FERRANTI. Dated June 5th.

10,952. "Improvements in electrodes." C. HOEPFNER. Dated June 5th.

10,967. "Improvements in electrical switches." J. H. TUCKER. Dated June 6th.

10,978. "Improvements in electric measuring instruments." W. T. GOOLDEN and S. EVERSHED. Dated June 6th.

11,022. "Improvements in alternate current rectifiers and apparatus connected therewith." S. Z. DE FERRANTI. Dated June 6th.

11,046. "Improvements in starting apparatus of gas and oil engines." C. BARKER. Dated June 7th.

11,059. "Methods of and apparatus for varying the frequency and number of phases in a polyphase electric current, and for converting alternating electric currents into continuous currents, and for other purposes." H. A. ROWLAND. Dated June 7th.

11,069. "Improvements relating to the transmission of signals through submarine telegraph cables." A. MUIRHEAD. Dated June 7th.

11,100. "Improvements in electric dental motor apparatus." F. N. DENISON. Dated June 7th. (*Complete.*)

11,123. "Electro protective system for locks." B. W. WELLS and M. MARTIN. Dated June 8th. (*Complete.*)

11,136. "Improvements in the regulation of electric distribution systems." R. WOOD. Dated June 8th.

11,145. "Improvements in or appertaining to apparatus for consuming smoke and economising fuel." T. T. VERNON. Dated June 8th.

11,160. "Improvements in apparatus for starting electric motors." H. W. RAVENSHAW and Messrs. EASTON, ANDERSON & GOOLDEN, Ltd. Dated June 8th.

11,187. "Improvements in steam turbines and other rotary motors." R. PATERSON and M. PATERSON." Dated June 9th.

11,211. "Improvements in railway electrical signalling apparatus." W. GRIMES. Dated June 9th.

11,219. "Incandescent electric lamps and sockets therefor." C. A. HUSSEY. Dated June 9th. (*Complete.*)

11,225. "Improvements in and relating to arc electric lamps." H. BEVIS and H. HIRST. Dated June 9th.

11,233. "An improved process and apparatus for the manufacture of zinc oxides, sulphates and sulphides, from zinc ashes, zinc blende, carbonate of zinc, and other ores of a complex nature, such as ores containing lead, zinc, silver, copper, manganese, iron or other metals in combination." A. CROSSLEY. Dated June 9th.

11,241. "An improved electric lamp." F. R. BOARDMAN. Dated June 9th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1893.

6,004. "Improvements relating to the paper carriages of typewriters and printing telegraphs." F. E. SUDDARD. Dated March 21st. The objects of the present invention are: (1.) To enable a typewriter operator to print the whole of a page without directly touching the platen. (2.) To return the platen automatically to its normal position. (3.) To remove the paper already printed and expose a new page to impression. (4.) To see what has been printed without lifting the platten. (5.) To complete instantaneously without using the space lever any line already begun. 4 claims.

6,205. "Improvements in methods of and apparatus for distributing and regulating the distribution of electricity for lighting and motive power and other purposes." R. WOOD. Dated March 23rd. Consists in forming a way for a bare electric conductor by a continuous length of glass or other insulating tube or other tube, stopped at each end by a perforated India-rubber cork, supported on glass or other insulating support, suitably imbedded in bitumen or other material, the whole so cased in iron or other material that the bitumen, even if it melted, would be constrained to remain in position, and by a combination of such ways and bare conductors with service and junction boxes in forming a system of mains for the distribution of electric energy. 3 claims.

6,233. "Improvements in electric clocks." E. DU BOIS. Dated March 23rd. Relates to that class of clock in which electricity is used for the purpose of winding up or driving the clock works. 8 claims.

9,326. "Improvements in and relating to ship's telegraph dials." J. W. RAY. Dated May 10th. Consists of painting the opal or glass used for this purpose with black or other dense colour, leaving the orders or name, or other matter, on dial the same colour as the glass or opal; the object being to shut out as much light as possible from the oil lamp, or electric light, used for illuminating these dials, and yet leaving the orders or name, or other matter, on dial distinctly visible, without causing a glare liable to affect the officer's eyes on dark nights. 3 claims.

9,380. "Improvements relating to automatic breaking of current circuit for electric lamps or other devices." R. HADDAN. (A communication from abroad by A. Reisinger, of Berlin.) Dated May 10th. The purpose of this invention is to provide an apparatus to be inserted in connection with an electric circuit for the purpose of automatically interrupting the said circuit after a certain interval of time and maintaining the same interrupted or broken until such time as an appropriate movement is given to a part of the apparatus for reconstituting the circuit and again suffering the current to flow for the aforesaid interval or space of time. 1 claim.

9,557. "Improvements in dynamo-electric machines and electric motors." H. N. PRENTICE. Dated May 12th. The object of the invention is to provide a dynamo-electric machine or motor in which high magnetic induction can be employed without objectionable heating or other objections, and further in which the air gaps are small so that the weight of copper necessary is reduced to a minimum, a good mechanical construction being also secured. 3 claims.

10,942. "Improvements in primary voltaic batteries." W. WALKER and F. R. WILKINS. Dated June 5th. Claim:—A single liquid battery consisting of a porous cell containing the exciting liquid in which the zinc or positive element of the battery is suspended the other or negative element, carbon in the form of powder and coarse grains, being retained in position around the outside of the porous cell by means of a wire gauze casing the whole being constructed and arranged substantially as described and illustrated in the drawing.

24,517. "An improved advertising reflector for the top of electric light globes." F. J. MOCKLER. Dated December 20th. Consists of a deflecting shade, or sloping crown resembling in shape an inverted cone without an apex, placed near the summit of the globe of the electric lamps used for street lighting and like purposes. 1 claim.

24,911. "Improvements in electric cables and in the method of making the same." T. J. DEWEES. Dated December 27th. Relates to dry cables. The inventor applies to the cable or conductor, preferably after it has been dried in the usual manner, a moisture absorbing medium, such as powdered calcined lime, or an equivalent substance having a strong affinity for water, which operates to absorb any moisture that may remain in the fibrous coverings of the wire or wires after they have been dried by the usual methods, or any moisture that may be communicated to them upon exposure as in the making of a splice or terminal connection, or through breaks or leaks in the sealed casing or covering. 7 claims.